Aviation Week and Space Technology

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September 5, 1960

SPECIAL REPORTS:

Logistic Plans For Propellants

•

Avionic Cycling

First Production Lockheed JetStar

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Over 250 of these reliable vehicles have been launched since 1946—forty during the IGY alone. Typical missions include: studies of atmospheric composition; micrometeorite investigations; ionization, radiation, and magnetic field determinations; aeromedical experiments; high-altitude photography; re-entry problems; communications; and component testing.

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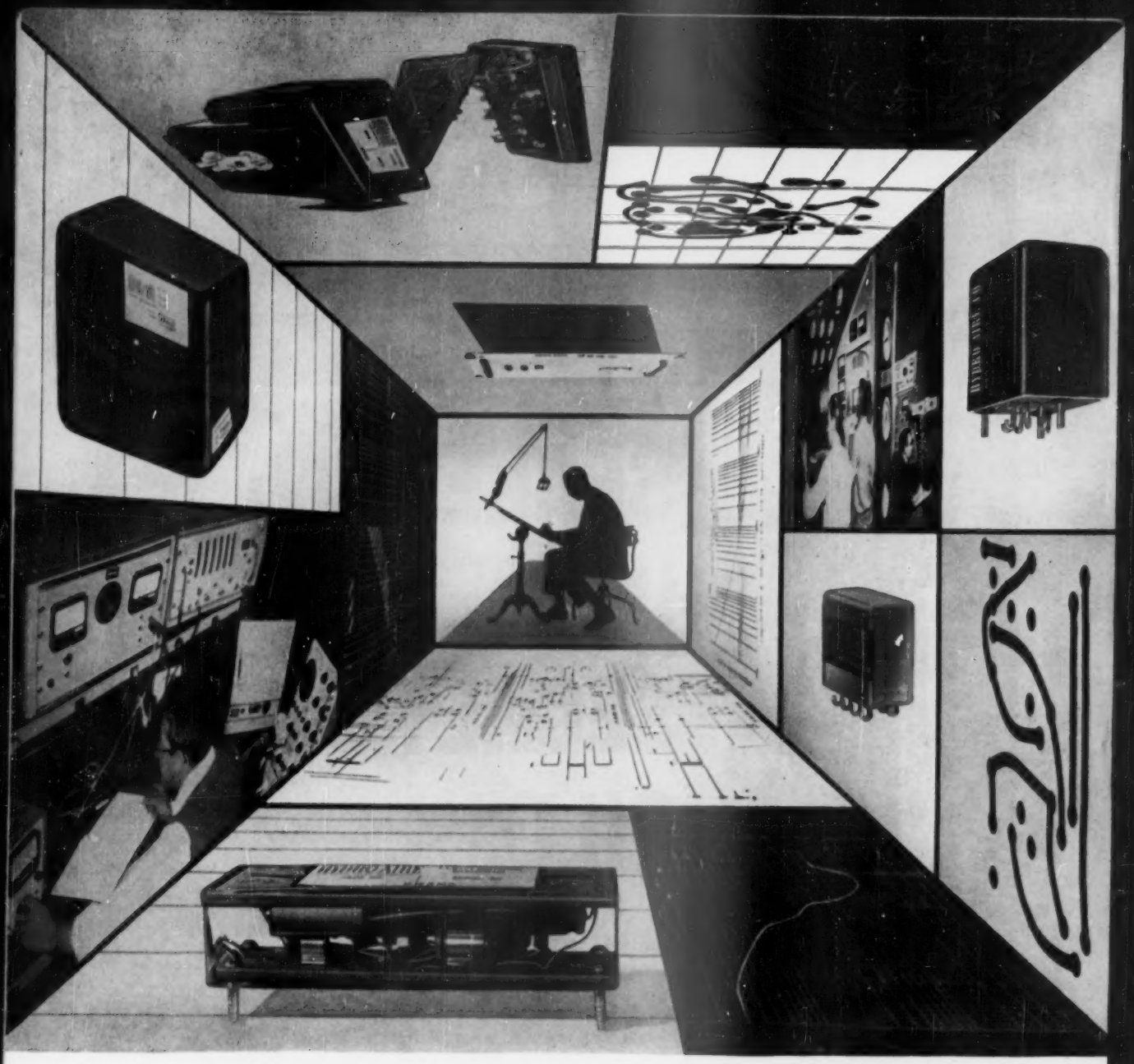

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INERTIAL NAVIGATION / ARMAMENT AND FLIGHT CONTROL / COMPUTERS AND DATA SYSTEMS

AVIATION CALENDAR

Sept. 12-13—Sixth Annual Titanium Metallurgy Conference, New York University's College of Engineering, Bronx, N. Y.

Sept. 12-16—16th Annual General Meeting, IATA, Copenhagen, Denmark.

Sept. 12-16—Second International Congress, International Council of the Aeronautical Sciences, Zurich, Switzerland.

Sept. 12-16—First Annual USAF Safety Congress, Mission Inn, Riverside, Calif. Sponsor: Office of the Deputy Inspector General for Safety, USAF, Norton AFB.

Sept. 14-16—Annual Meeting, National Assn. of State Aviation Officials, Wort Hotel, Jackson, Wyo.

Sept. 15-16—15th Annual Meeting, Armed Forces Chemical Assn., Sheraton-Park Hotel, Washington, D. C.

Sept. 15-16—Eighth Annual Engineering Management Conference, Morrison Hotel, Chicago, Ill.

Sept. 19-22—National Symposium on Space Electronics and Telemetry, IRE, Shoreham Hotel, Washington, D. C.

Sept. 20-22—13th Annual Meeting & Forum, National Business Aircraft Assn., Ambassador Hotel, Los Angeles, Calif.

Sept. 21-25—National Convention and Aerospace Panorama, Air Force Assn., Civic Auditorium and Brooks Hall, San Francisco, Calif.

Sept. 24—Reunion, 1st Air Commando Group, concurrent with AFA Convention. Contact: Lt. Col. R. E. Moist, USAF, 7025 Hayvenhurst Ave., Van Nuys, Calif.

Sept. 25-27—24th Annual Convention, International Northwest Aviation Council, Harrison Hot Springs, British Columbia.

Sept. 27-30—Space Power Systems Conference, American Rocket Society, Miramar Hotel, Santa Monica, Calif.

Oct. 2-10—Federation Aeronautique Inter-

(Continued on page 6)

AVIATION WEEK and Space Technology

September 5, 1960

Vol. 73, No. 10

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Engineering notes from the **SM/I REPORTER**

BY STANLEY M. INGERSOLL, *Capabilities Engineer*

Report No. 9

TMC 601 LOX Tanking Computer System

Typical of our extensive participation in missile fuel management is our TMC 601 the main building block in the process of obtaining a completely automatic propellant loading system for missiles. It accurately measures, controls and indicates the level of liquid oxygen in missile tanks. The computer monitors the weight of the propellant aboard a missile, compares it with the desired weight, allows for tank diameter and propellant density correction and controls the flow of propellant to the missile. A two mode control system facilitates the rapid and accurate loading of the missile. The first mode permits extremely high pumping rates until 98% capacity is reached. The second mode then controls a precise proportioning valve which fills the tank to within 0.1% accuracy and provides for continuous topping. Entirely encased in a protective cover to withstand the extreme conditions generated by a firing, the TMC 601 measures the static head of the liquid in a tank by means of a highly refined pressure transducer.

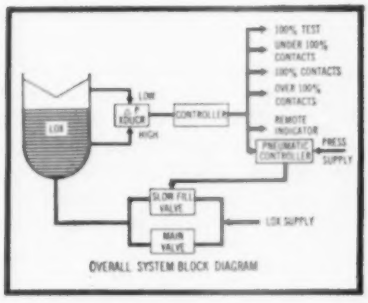
The TMC 601 does not require calibration after installation and can be easily and rapidly modified for new missile or tank configurations.

Typical Performance Specifications

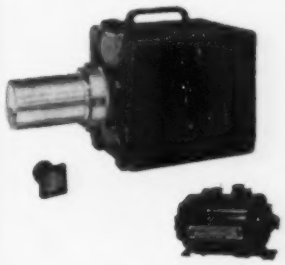
Input Power ..... 115 volts, 400 cycles, 15 watts
28 volts D.C., 2 Amps.
115 volts, 60 cycles, 100 watts (heater)
25 PSIG—clean, dry air-pneumatic supply to TR 2013

Pressure ..... 1) Differential Pressure (liquid head) 10 PSIG (Range from 0.5 PSIG to 22 PSIG available)
2) Line Pressure 50 PSIG
3) Proof Pressure 90 PSIG

Accuracy ..... ±0.25% under severe environmental conditions
±0.1% under normal field temperature conditions of 50°F to 125°F



OVERALL SYSTEM BLOCK DIAGRAM



For more information and complete operating specifications, write or wire SM/I today. Address your inquiry to Stanley M. Ingersoll, Capabilities Engineer.

SM/I SERVOMECHANISMS/INC.

Los Angeles Division
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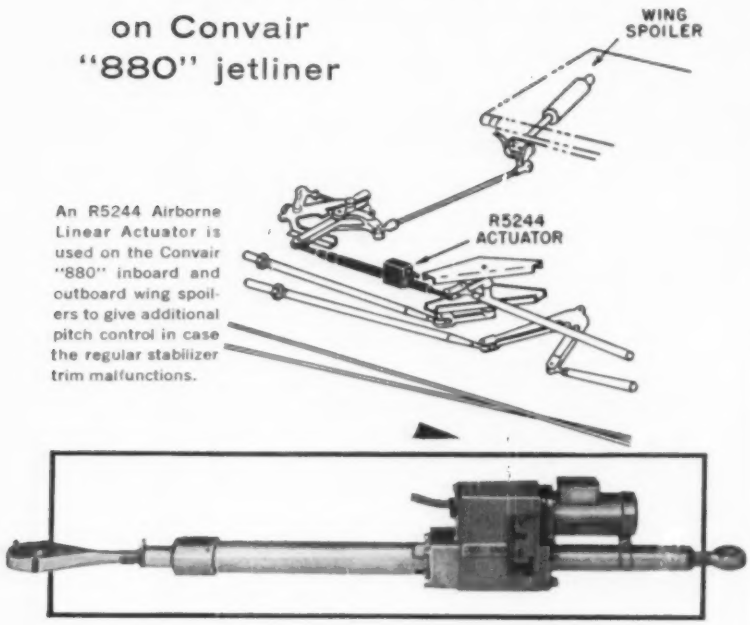
Hawthorne, California

Airborne actuator selected for wing spoiler systems

on Convair "880" jetliner



An R5244 Airborne Linear Actuator is used on the Convair "880" inboard and outboard wing spoilers to give additional pitch control in case the regular stabilizer trim malfunctions.

Airborne's linear actuators are used by Convair Division of General Dynamics Corporation in the Convair "880" jetliner to provide a secondary flight control system to retain control of aircraft attitude should the primary control surfaces become inactive. By electrically controlling the actuators through a set of switches in the cockpit, the pilot can fly the "880" using the wing spoilers.

Convair's design problem called for an actuator that would operate effectively from sea level to 40,000 ft., at temperatures ranging from −65° to +140°F, and with a duty cycle of 10 sec. on, 5 min. off at a maximum tension or compression load of 320 lb. without any risk of failure even after being unused for long periods of time. Airborne provided a specially built R5244 unit meeting these requirements with a total weight of only 3 lb.

This is only one example of many specially built Airborne actuators relied on by aircraft designers to carry out vital functions in modern missiles and aircraft. Whatever your special design problem, we will build an actuator to your specifications that will do the job dependably and safely. Where your requirements are not unique, we can provide a line of modular-type actuators, both linear and rotary, that can simplify design and specification. Give us the facts on your particular need and we will be happy to submit a proposal. Contact any of our offices for further information.

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AVIATION CALENDAR

(*Continued from page 5*)

nationale Annual Meeting, Barcelona.

Oct. 3-5—Sixth National Communications Symposium, Institute of Radio Engineers, Utica, N. Y.

Oct. 3-5—Seventh Annual Meeting, Institute of Radio Engineers' Professional Group on Nuclear Science, Gatlinburg, Tenn. Cosponsor: Oak Ridge National Laboratory.

Oct. 3-5—National Midwestern Conference on Air Logistics, Institute of the Aeronautical Sciences, Tulsa, Okla.

Oct. 3-5—First International Air Traffic Control Conference and Fifth Annual Meeting of the Air Traffic Control Assn., Sheraton-Palace Hotel, San Francisco.

Oct. 4-6—Sixth Conference on Radio Interference Reduction, Chicago, Ill. Sponsors: Armour Research Foundation; U.S. Army; U.S. Navy; USAF; Institute of Radio Engineers' Professional Group on Radio Frequency Interference.

Oct. 5-7—Briefing Session on Opportunities in Space-Age Technology, American Management Assn., Hotel Astor, New York, N. Y.

Oct. 6-8—Annual Convention, Airmail Pioneers, El Cortez Hotel, San Diego, Calif.

Oct. 6-8—Society of Experimental Test Pilots Symposium on "Omni-sonic Flight," Ambassador Hotel, Los Angeles, Calif. Fourth Annual Awards Banquet, Oct. 8.

Oct. 6-9—Annual Meeting, National Pilots Assn., Western Hills Lodge, Wagoner.

Oct. 8—Third Annual National Aero Club Football Fly-in, Michigan vs. Duke, Ann Arbor, Mich.

Oct. 10-12—1960 National Electronics Conference and Exhibition, Hotel Sherman, Chicago, Ill.

Oct. 10-14—Society of Automotive Engineers National Aeronautic Meeting, Ambassador Hotel, Los Angeles, Calif.

Oct. 14-15—Symposium on High-Speed Processing, Society of Photographic Scientists & Engineers, Washington, D. C.

Oct. 14-15—15th Midwest Conference, American Society for Quality Control, Broadview Hotel, Wichita, Kan.

Oct. 17-18—Joint Meeting, Institute of the Aeronautical Sciences and Canadian Aeronautical Institute, Queen Elizabeth Hotel, Montreal, Canada.

Oct. 17-21—National Safety Council's 48th National Safety Congress, Conrad Hilton Hotel, Chicago, Ill.

Oct. 19-21—Annual Convention, Southeastern Airport Managers' Assn., Far Horizons Motel, Sarasota-Bradenton, Fla.

Oct. 19-21—Symposium on Space Navigation, Institute of Radio Engineers, Deshler-Hilton Hotel, Columbus, Ohio.

Oct. 19-21—Annual Meeting, Society for Experimental Stress Analysis, Hotel Claremont, Berkeley, Calif.

Oct. 20-21—National Symposium on Hypervelocity Techniques, Institute of the Aeronautical Sciences, Shirley-Savoy Hotel, Denver, Colo.

Oct. 24-26—Medical and Biological Aspects of the Energies of Space, Unclassified Symposium, Granada Hotel, San Antonio, Tex. Sponsored by the School of Aviation Medicine. Arranged by Southwest Research Institute.

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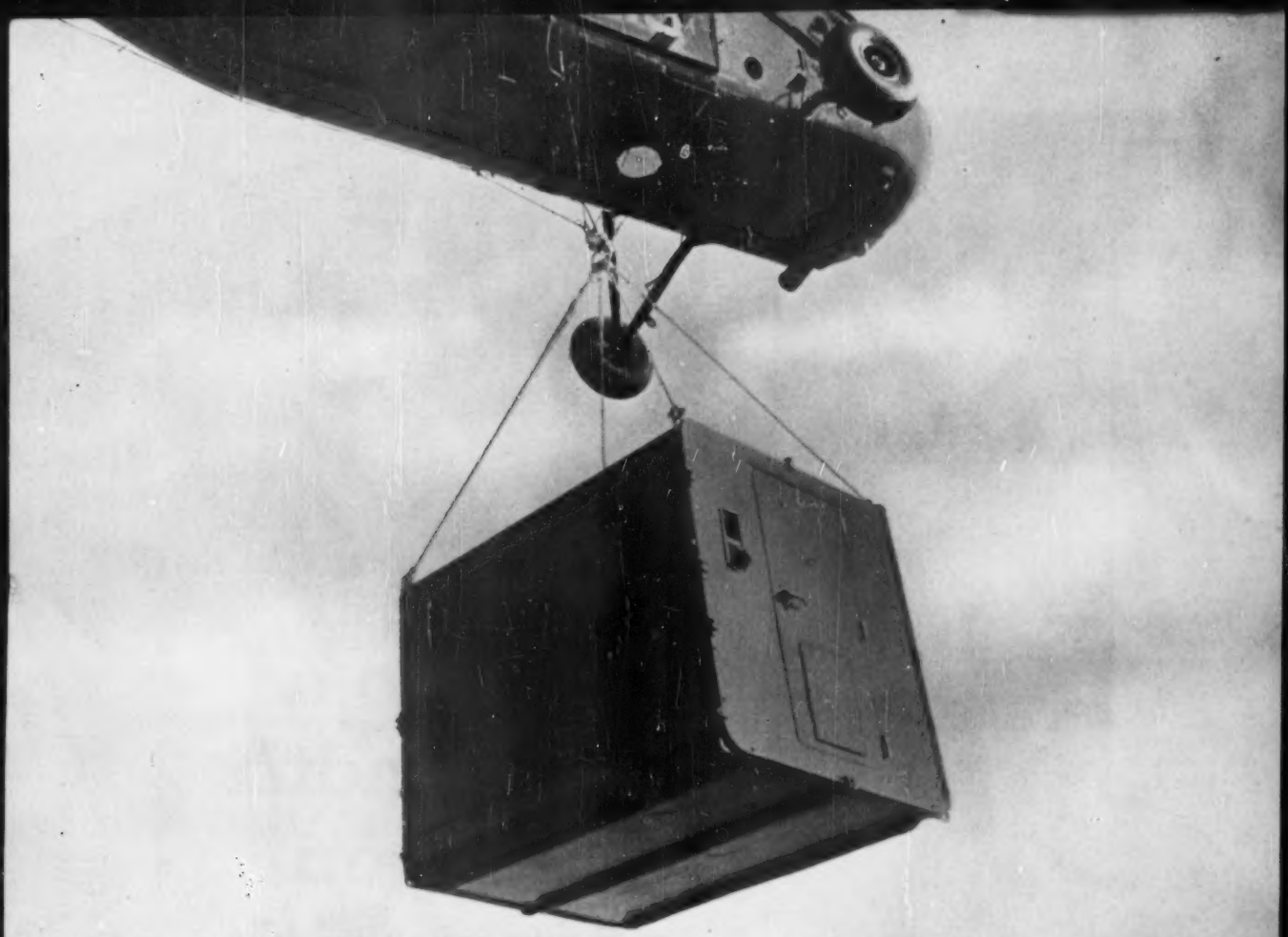

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We actually drop it from a helicopter, dump it from a truck, hammer it, freeze it, heat it, even drown it. We wind up with a precise measure of reliability, above and beyond specification interpretation — extra reliability that's part of every piece of Craig equipment.

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In short — greater reliability for mobile electronic and missile support systems. That's our objective, and that's what we sell.

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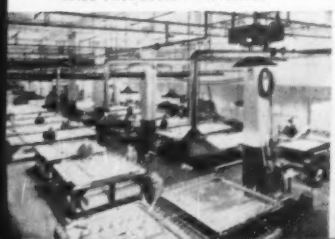

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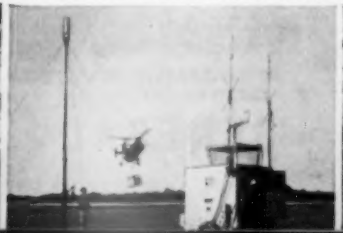

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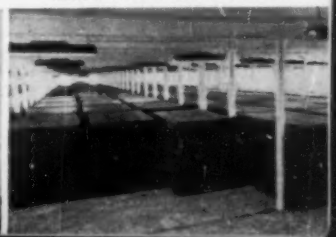

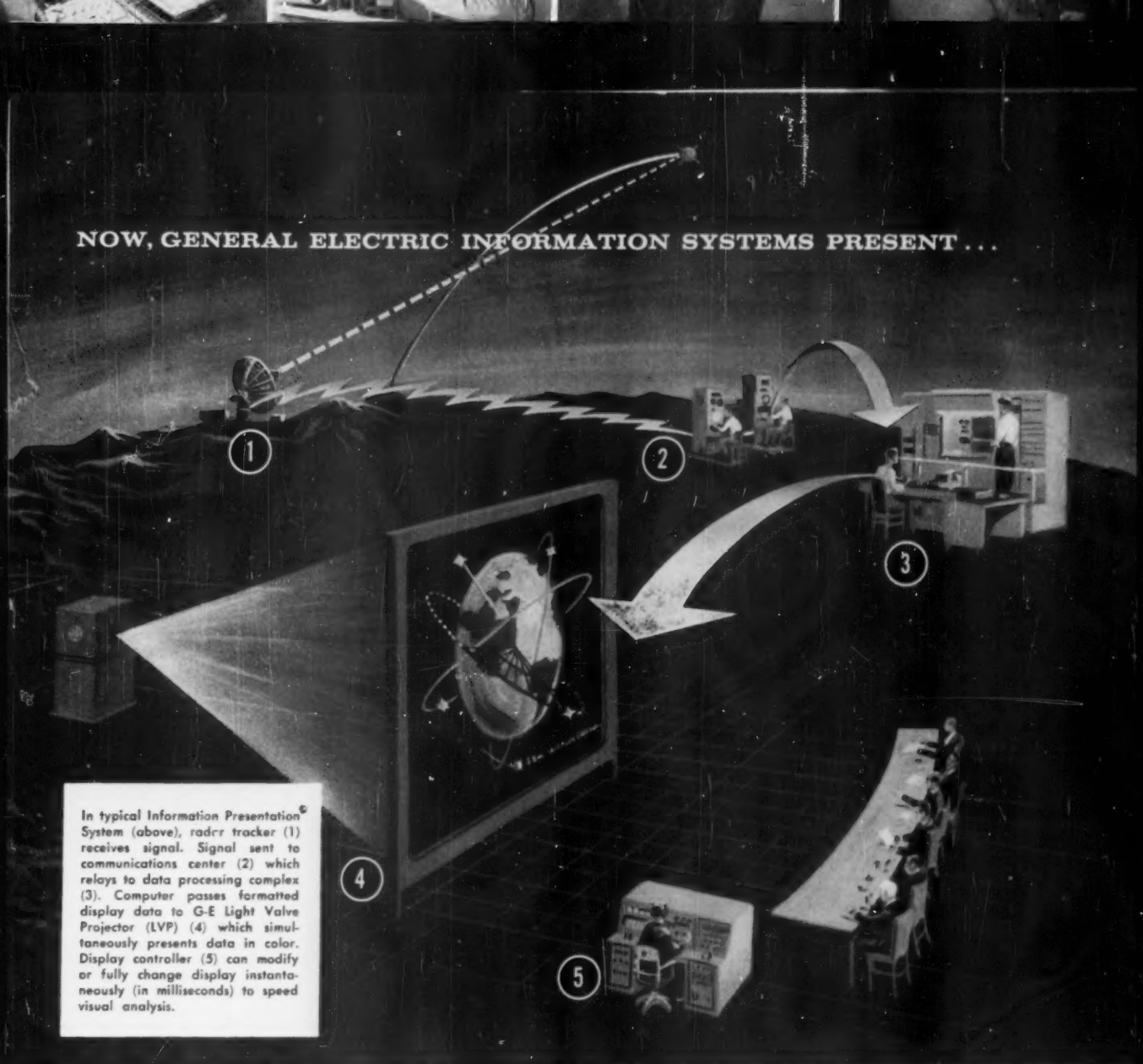

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- logistics
- intelligence

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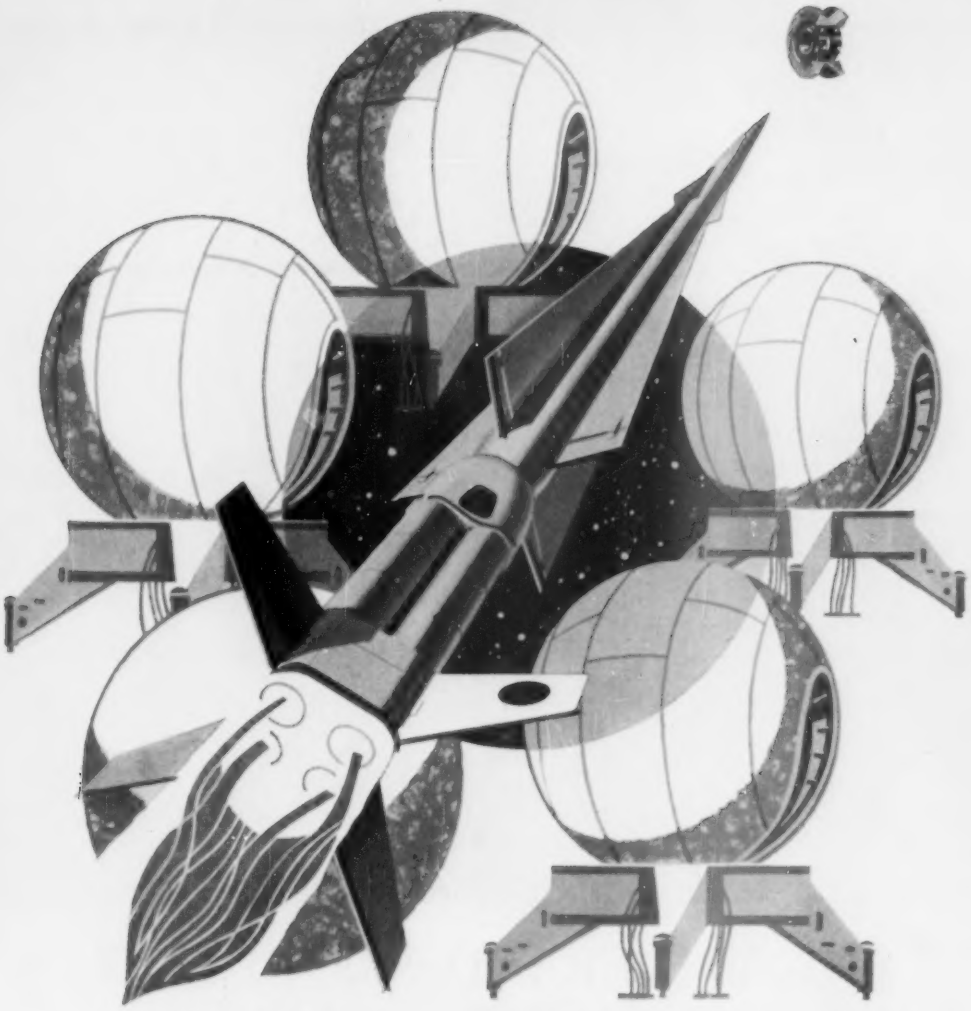

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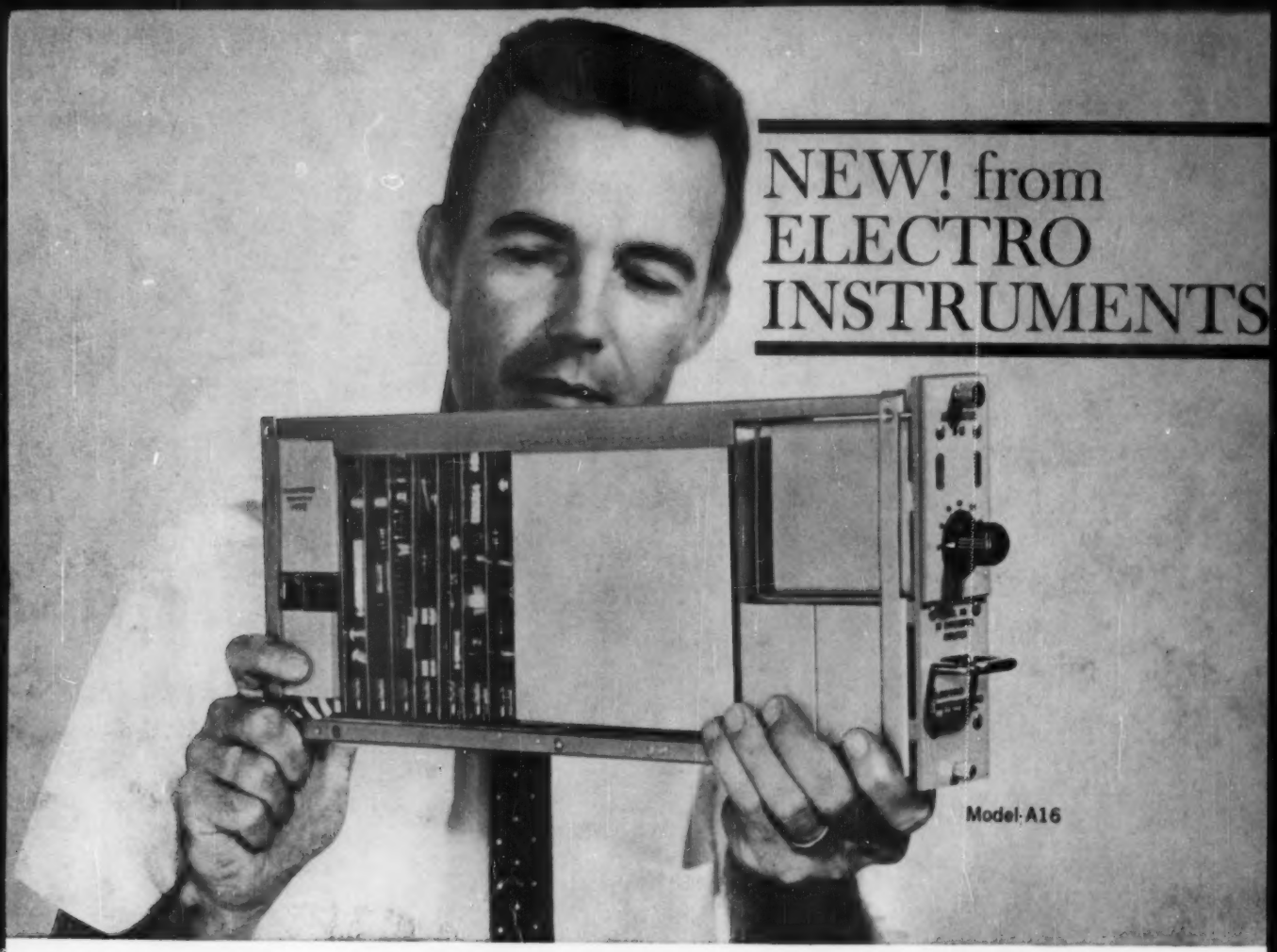

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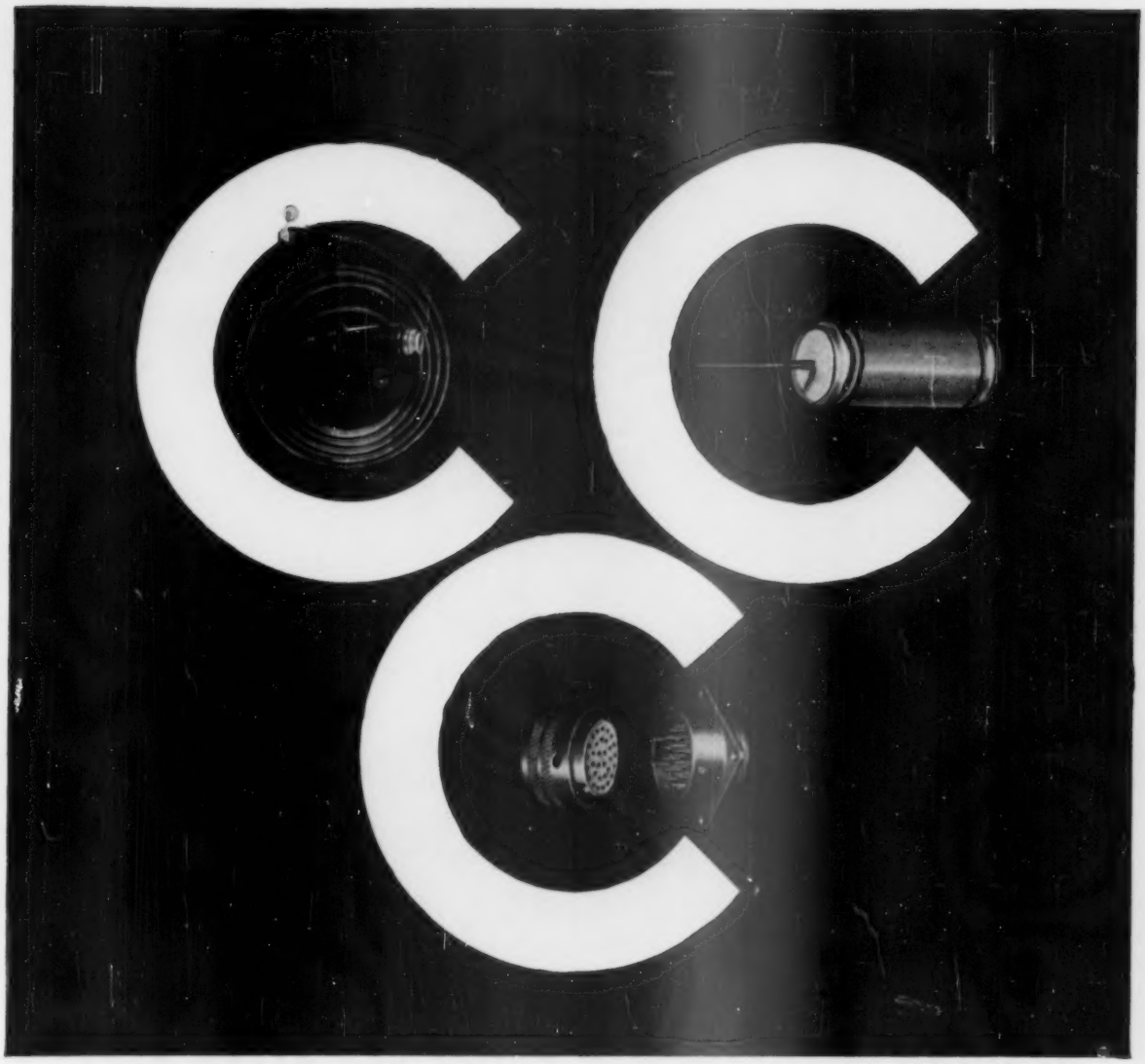

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NERV POWER

AEROLAB ROCKETS HELP PROBE VAN ALLEN BELT

Better, safer design of manned space vehicles is expected from a closer study of the Van Allen radiation belt to be made by Project NERV (Nuclear Emulsion Radiation Vehicle) in which NASA has awarded Aerolab a prime contract.

ARGO D-8 rockets, developed by Aerolab, will boost 125-lb. instrumentation payloads, in the nose cones, to 1500-mile altitudes and 1700 miles down the Pacific Missile Range, to measure nuclear bombardment above the atmosphere. Prompt recovery of the nose cones from the ocean by Navy ships demands exacting computation by Aerolab engineers to precisely plot the ballistic trajectory and impact point of the payloads.

This is typical of Aerolab's capability in arranging solid fuel rockets in combinations to provide low-cost, high-performance space probes for the acquisition of vital scientific data.

A pioneer in aerophysics research since 1946, Aerolab's capabilities now complement those of Ryan Aeronautical Company for solving design, development and fabrication problems in such advanced areas of space as: electronic navigation, automatic guidance, recovery systems, missile design, reaction controls, propulsion systems, solid state devices, and instrumentation packages.

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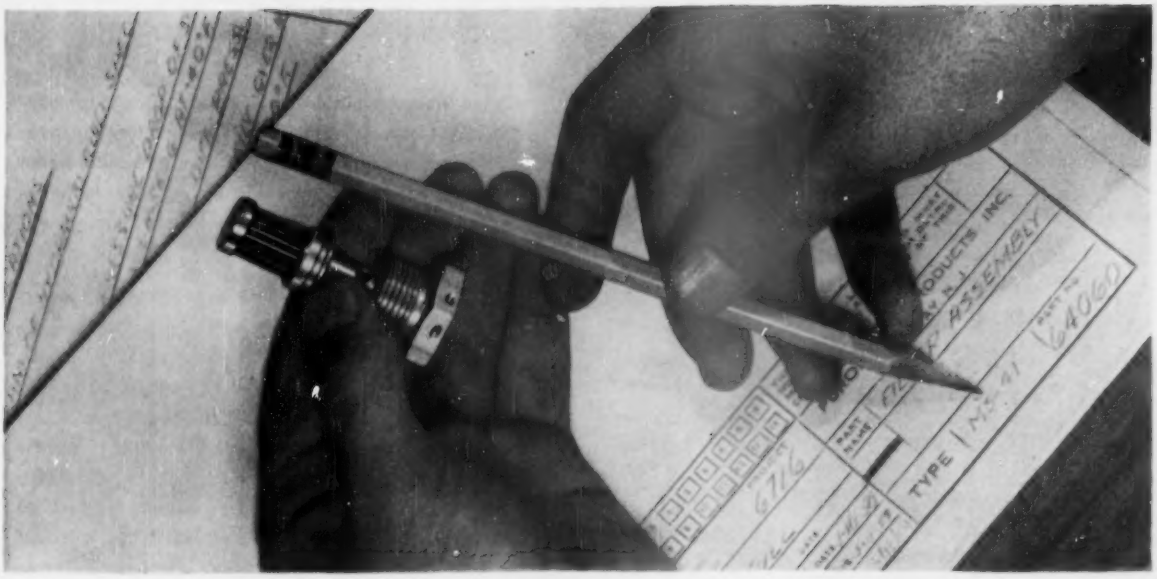


Miniaturized cavity-type filter packs 4.2 square inches of filtering area into 1" x 9/16" element

Purolator develops thumb-nail size element to protect hydraulic control circuits on Army's Hawk Missile mobile launcher.

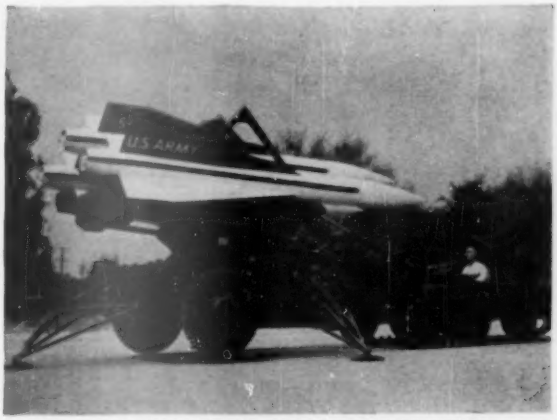
How small can you make an element that must filter 2 gpm hydraulic oil at 2500 psi at any temperature within a 315° range? Purolator's new miniature cavity-type hydraulic filter is the best answer to date. Here's why:

4.2 square inches of convoluted stainless steel wire cloth are packed into this miniature filter. This element, which weighs 0.25 ounces, filters two gallons per minute of hydraulic oil, at temperatures ranging from —40° to + 275° F. The element will withstand 2500 psi differential pressure without collapsing.

The element is made up of a total of ½-mile of stainless steel wire, woven into wire cloth and convoluted to extend filtration area. This element will remove 98% of all particles whose two smallest dimensions are larger than 10 microns, and 100% of all particles measuring 25 microns or more.

The picture at the top of the page shows you the complete filter assembly, ready for installation in the hydraulic control system. The overall length of the unit is 2 1/32"; maximum overall diameter is 1". Total weight is slightly over 1 ounce. Designed as a cavity-type unit, the filter is installed simply by screwing it into the hydraulic system so the filter element intercepts oil flow. The element can be removed, cleaned and replaced without special tools.

The picture at right shows the mobile launching platform for the Hawk Missile. The compactness and mobility of the



launcher, and the probability that it would be subjected to severe jolting, made it necessary to specify as small a filter as possible, and one that could be integrated with the rest of the system for maximum simplicity and durability.

The Purolator engineers who developed this new miniature cavity-type filter are available now to design a filter to meet your specifications. Simply contact Purolator Products, Inc., Department 3096, Rahway, New Jersey.

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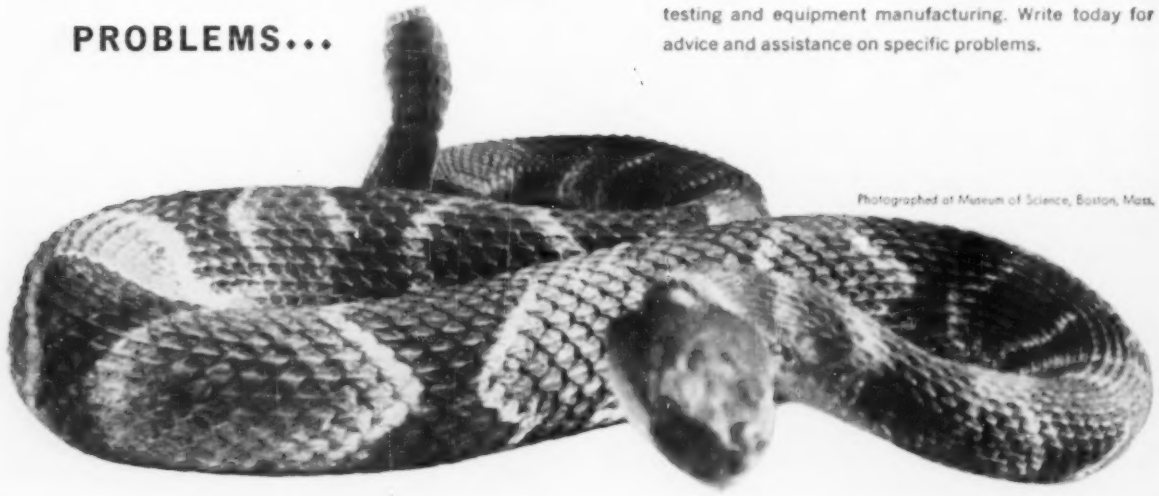

Photographed at Museum of Science, Boston, Mass.

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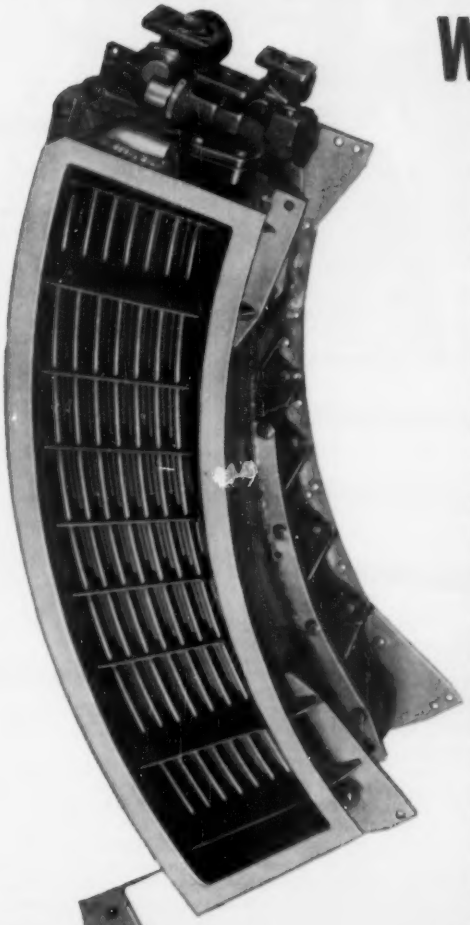
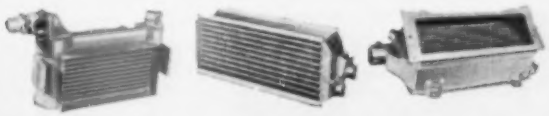


NEW YORK TO PARIS IN JUST OVER 6 HOURS—THE MIGHTY NEW 707 "320" DEPENDS ON HARRISON FOR RELIABLE OIL COOLING!

Meet a great heat leveller! It's Harrison's new oil temperature regulator, engineered expressly to perform three major cooling jobs on the magnificent new Boeing Intercontinental jet airliner. *Cooling the engine oil . . . cooling the oil in the turbo compressor . . . cooling the oil in the constant speed drive*—this is the three-in-one temperature control service that Harrison handles! What's more, this new heat exchanger incorporates, as an integral part of the design, a special protective feature which effectively guards against damage from ice balls and other critical weather hazards. Harrison's long experience and research in the heat-transfer field assure complete reliability . . . peak temperature-control efficiency under the most severe operating conditions. If you have a cooling problem, look to Harrison for the answer.



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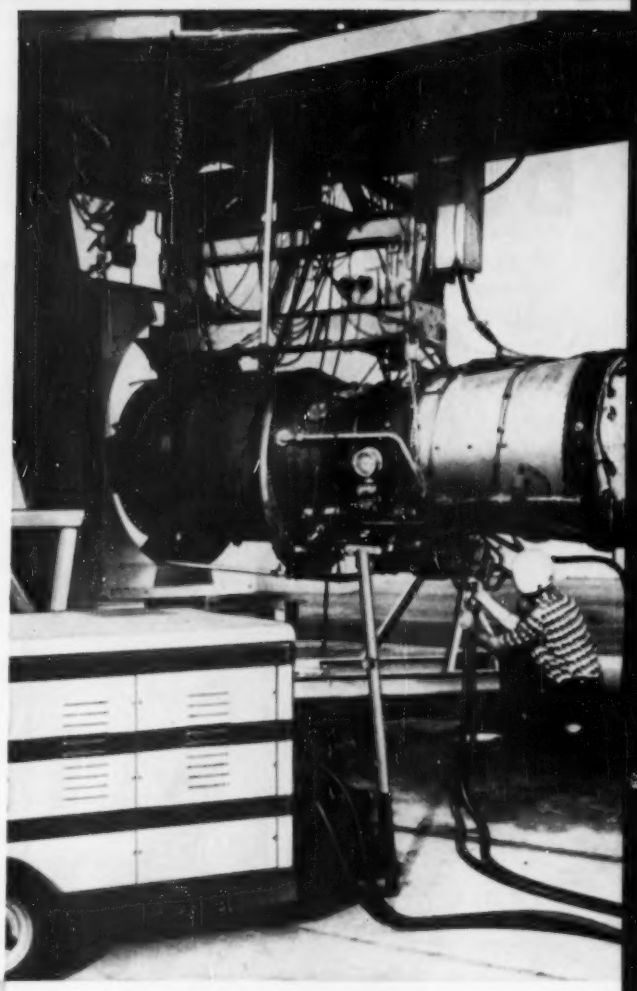
In technology and facility, Vickers continually matches your need

Auxiliary power units pioneered for aircraft turbine starting by Vickers combine high efficiency with minimum size and weight for the power delivered. Because starter characteristics are closely matched to engine requirements, they provide smooth, steady acceleration of the engine through the firepoint range giving the best possible chance of proper "lighting off" and avoiding aborted starts.

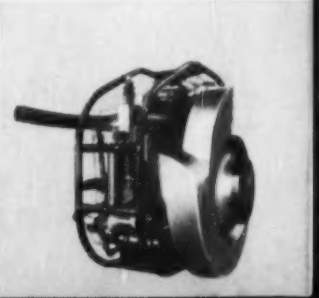
Dual-purpose units developed by Vickers as an outgrowth of pioneering work in hydraulic starting offer further benefits in weight saving. These units are used as a motor in engine starting, as a pump to supply accessory power during normal operation. Reduced cost and ground support requirements plus increased versatility and simpler remote area operation are other major benefits. Write for Bulletin A-6001.



PROVED PERFORMANCE of hydraulic starting for jet engines is demonstrated by this cart that has performed more than 2,500 trouble-free starts in a 2-year period. Cart size is due to divergent requirements of three different engines. Prime mover power requirement is only 25% of that needed for other starting methods due to inherent high efficiency of the hydraulic transmission.

JET PROP STARTING demonstration uses engine-mounted starter motor and ground cart power supply. Starter cutout speed of approximately 8,000 rpm was reached in 34.5 to 40 seconds during series of observed test starts.

MULTI-PURPOSE PUMP MOTOR (left) is pump when driving hydraulic starter becomes motor during normal flight to drive 15 KVA generator. **HELICOPTER STARTER** (right) is 35 hp unit, starts 1,900 shaft hp engine readily.



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FLUID TRANSFER

September 5, 1960

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COVER: First production Lockheed JetStar powered by four tail mounted Pratt & Whitney JT12 engines is flying at Lockheed's Marietta, Ga., plant. First four production aircraft will go into the Federal Aviation Agency certification program, four for flight test and one for static (see page 79).

PICTURE CREDITS

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83,331 copies of this issue printed

FLUID TRANSFER

NEW ERA OF WESTERN DEFENSE

Navy launches first Polaris missile from submerged sub

Erupting from Atlantic waters off Cape Canaveral July 20, a slim white Polaris missile fired from the nuclear submarine U.S.S. George Washington launched a new era of defense. Arching skyward on a column of flame, the Polaris made its clear contribution to the security of free nations before it shook off its last drops of brine. To further demonstrate the missile's dependability, the Navy then launched a second Polaris from the nuclear sub. This was the climax of a remarkable 47-month race to develop the Navy's Fleet Ballistic Missile Weapon System. Combined for the first time were a nuclear-powered submarine, hidden in ocean depths and able to cruise anywhere, unseen for months, and a powerful missile, so compact a single sub can carry 16 of them with nuclear warheads. The Polaris gives America a defense that cannot be overwhelmed by surprise attack, a defense that will work for peace by making aggression unthinkable. Lockheed is prime contractor and missile system manager for the Polaris missile. Aerojet-General Corporation is the subcontractor responsible for the missile's rocket motor, General Electric Corporation for its guidance system, and Westinghouse Electric Corporation for the launch system. The U.S.S. George Washington was built by the Electric Boat Company.

LOCKHEED

MISSILES & SPACE DIVISION, SUNNYVALE, CALIFORNIA

EDITORIAL

Space Technology Comes of Age

Looking back on the eventful summer of 1960, we predict that this will be the period noted by technical historians as marking the time when space technology came of age and took its place as a major force on the technological frontier of our era. There was a determined band of scientists, engineers and enthusiasts who trumpeted the importance of space technology for years before the Soviet's Sputnik I wrote the first paragraph in its history. There was also a large contingent of scientists, industrial leaders and prominent politicians who for many months after Sputnik I began its beeping failed to perceive even the vaguest outlines of the future it portended. Their learned carpings against the value of space research are so recent that we can still hear the echoes of:

"Its all space and no technology."

"There is not one iota of military significance in satellites."

"We do not intend to play a game of basketball in outer space."

All of this was uttered by distinguished citizens in the post-Sputnik era.

However, the achievements in space technology during the summer of 1960 by the United States and the Soviet Union leave no argument against the thesis that this endeavor has become one of the most exciting technical explorations in history, has validated some of its basic concepts and has demonstrated its ability to serve a variety of useful purposes. These achievements have been reported in precise detail in the editorial pages of Aviation Week during the past few months, and, of course, include the Tiros weather reconnaissance satellite, the Echo communications relay satellite, the Discoverer series, the Pioneer V space probe and the Soviet spaceship experiments which successfully returned to earth alive a variety of living organisms after orbiting in space.

Although we must accept the probability that the Soviets will score another notable first in space history by beating this country to orbiting and recovering a man from space, it is apparent that the U. S. space technology program has progressed faster and on a broader front than anybody might have hoped in the gloomy months after Sputnik I. Credit for this achievement must be divided between the National Aeronautics and Space Administration and the Ballistic Missile Division of the Air Force for their organizational, funding and directional activity and the vast army of scientists, engineers and technicians in industry which has contributed the experimental hardware that has performed so well in view of the major pioneering the entire effort represents. Both NASA and BMD have exhibited considerable dogged courage in sticking to their technical goals despite the unfavorable public reaction from the inevitable early experimental failures. Observers of space technology's political aspects are well aware of the solid line play contributed by NASA Administrator Keith Glennan in refusing to stop selling a reluctant White House and Budget Bureau on the necessity for an adequately funded space program, despite a series of rebuffs that might have discouraged a less determined leader, and for successfully resisting most attempts to pressure NASA into some spectacular but scientifically meaningless space experiments.

NASA has had its trying times, and few would contend that its present organization, personnel or programs could not stand improvement. But within the resources and the time period with which it had to start from scratch and produce a scientifically respectable space research program, it has done a job that has won international respect even from its Soviet competitors.

As the other major focal point for U. S. space technology's development, the Air Force through its Ballistic Missile Division of Air Research and Development Command has earned a solid "well done" for its performance during the first three years of the space age. The Discoverer program represents an extremely ambitious research effort whose success will lay the foundation for a whole generation of useful applications. The successes scored with Discoverer XIII and XIV satellites are a major milestone in the development of practical space technology in precise launching, orbiting and attitude control, re-entry and recovery techniques. Here too, BMD and its associated industry contractors displayed the type of courage and persistence required to bulldog any major experimental program through its early learning failures to the proof of its new principles. BMD, as noted earlier on this page (AW May 30, p. 21) has also made major contributions to the NASA program from its experience with ballistic missiles.

It is impossible to credit properly all of the agencies, people or programs that have contributed to the emergence of the U.S. space technology development program onto the plateau of achievement reached this summer, but we feel this exercise cannot be complete without special mention of the work done by the Douglas Thor missile as the workhorse booster of this initial era of space exploration. Although events undermined its significance as a military weapon, its readiness as a reliable provider of the most available power at the time made the initial space experiments possible, and its performance in this role has been notable. Of its 32 space launches, Thor functioned well on 28 shots, and of the 27 major successful U.S. space experiments, Thor has powered 16 as against 6 by the Jupiter, its closest rival.

Looking backward now from this plateau of achievement, we think that once the initial official skepticism over the possibilities of space technology and the reluctance to divert any of our national resources toward this purpose was overcome, the agencies charged with organizing and directing the program have done an effective job and the performance of industry supporting them has been truly startling. Looking ahead, it appears to be time to make a major re-evaluation of both our military and civil space programs aimed at taking bolder, longer steps into the future in areas where the technological foundation has been laid and at hastening the day when we can reap the rewards in operational space systems from the sizable investments we are making in space technology.

—Robert Hotz

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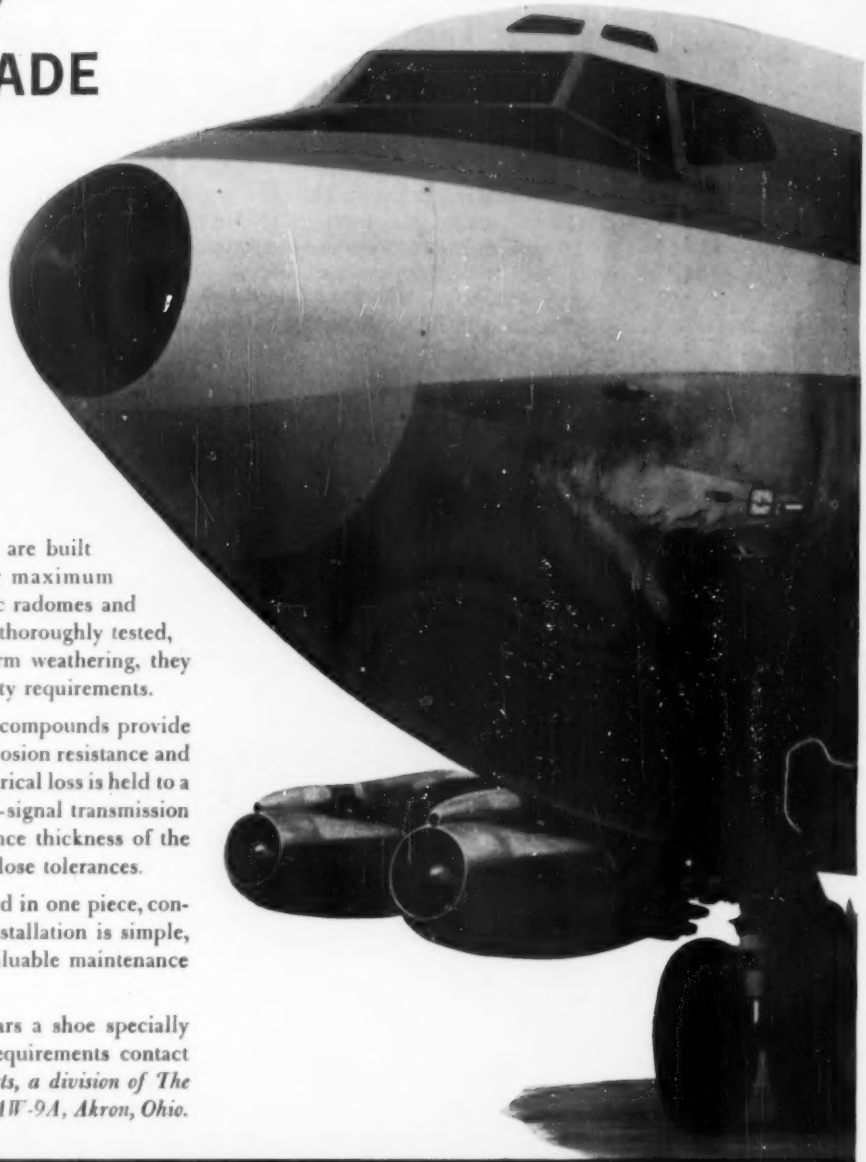
TAILOR-MADE RUBBER SHOES FOR WELL DRESSED RADOMES



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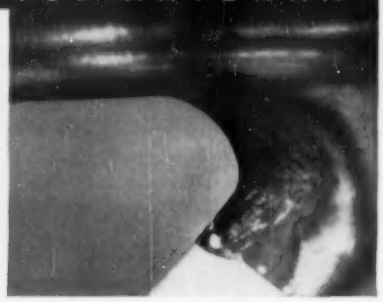
BFG erosion shoes are supplied in one piece, contoured to fit the part. Thus installation is simple, requires no special tools. Valuable maintenance man-hours are saved.

The well dressed radome wears a shoe specially made for the job. For your requirements contact *B. F. Goodrich Aviation Products, a division of The B. F. Goodrich Company, Dept. AW-9A, Akron, Ohio.*

EROSION SHOES ON BOEING 707 ANTENNA

UHF antenna

Fin probe antenna



Wing tip probe

B.F.Goodrich aviation products

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In the Front Office

Robert P. Sumberg, vice president and controller, Avco Corp.'s Research and Advanced Development Division, Wilmington, Mass., and **E. Douglas Kenna**, vice president-marketing.

George A. Fitzgerald, president, Permacel, New Brunswick, N. J., a division of Johnson & Johnson. **Robert S. Bradford** succeeds Mr. Fitzgerald as vice president-sales.

Floyd M. Gate, vice president-sales, Cannon Electric Co., Los Angeles, Calif.

John Fisher Carr, general counsel, Grumman Aircraft Engineering Corp., Bethpage, N. Y.

Dr. John S. Burgess, scientific director, Rome Air Development Center, Griffiss AFB, N. Y.

Howard A. Baxter, vice president-engineering, Norma-Hoffmann Bearings Corp., Stamford, Conn.

George C. Connor, senior vice president-marketing, Sylvania Electric Products, Inc., New York, N. Y.

A. R. Gale, vice president, Ampex Corp., Redwood City, Calif., and manager of Ampex International.

Dr. Knox Taylor Millsaps, director of the Air Force Office of Scientific Research and chief scientist of the Air Force Research Division, Washington, D. C. Also: **Maj. Gen. Daniel E. Hooks**, commander of the Air Research and Development Command's Air Force Research Division, Washington, D. C. **Maj. Gen. William M. Canterbury** will replace Gen. Hooks as commander of the Air Force Missile Development Center, Holloman AFB, N. M.

Brig. Gen. Joseph E. Gill, deputy commander for site activation at the AMC Ballistic Missiles Center, Inglewood, Calif.

George C. Prill, deputy director of the Federal Aviation Agency's Bureau of Flight Standards, Washington, D. C. Also: **Earl K. Yost, Jr.**, chief of the Statistics Division of FAA's Office of Management Services, and **Jesse L. Sternberger**, assistant chief.

B. V. Deltour, assistant to the president, Babcock Radio Engineering, Inc., Costa Mesa, Calif.

Honors and Elections

Milford G. Childers, a research and development engineer at Lockheed Aircraft Corp.'s Structures Division, will receive the Society of Automotive Engineers' Wright Brothers medal for his report "Preliminary Design Considerations for the Structure of a Trisonic Transport."

Dr. Herbert P. Broida and **Dr. Arnold M. Bass** of the National Bureau of Standards have received U. S. Department of Commerce Gold Medals for exceptional service. Dr. Bass is chief of the Bureau's Free Radicals Section; Dr. Broida is technical coordinator of free radicals research.

Donald W. Douglas, founder and board chairman of Douglas Aircraft Co., has received Sweden's Royal Order of Vesa with the rank of commander in recognition of his many contributions to civil aviation in Sweden and throughout the world.

(Continued on page 123)

INDUSTRY OBSERVER

► Soviet scientists theorize that there is a third radiation belt around the earth on the basis of data obtained from Lunik II. Russians say this third belt is located at "great distances" from the earth, well beyond the two Van Allen belts. Third belt is a plasma which is part of the earth's corona rather than an interplanetary ionized gas, according to Russian reports.

► **Air Force will fire a Minuteman ICBM from its mobile train early next year at Atlantic Missile Range. Train launches will follow test shots from the silo at AMR.**

► Lockheed Marietta Division is developing a jet pump aircraft, called the Hummingbird, with two turbine engines in the wing roots providing conventional straight-through air flow for forward flight. For vertical lift, flow is diverted into a fuselage chamber with doors which open at both top and bottom. High velocity jet exhaust directed downward draws in a large volume of free air, producing a large, relatively low velocity air stream for VTOL augmentation. Hiller and Avro also are studying VTOL aircraft using this principle.

► **Douglas Aircraft Co. management has set Sept. 15 for an intensive review of the company's engineering schedule in the Skybolt air-launched ballistic missile project. Aim is to pinpoint all problems which might slow the program's exacting schedule.**

► Atlas booster, first stage in the 264,000 lb. Atlas Able V vehicle which will launch the Pioneer VI lunar orbiter experiment scheduled for Sept. 22, will not use full range capability. Enough fuel for about 3 sec. burning time will remain at first stage cutoff.

► **Canadian interest in a turbine-powered de Havilland Caribou has been revived by the brush fire war airlift requirements of the Congo crisis. U. S. Army also has shown interest in a turbine version, and a General Electric T64 will be installed in a U. S. Army Caribou for use as an engine testbed.**

► Curtiss-Wright is dropping plans to use rotating combustion engines on its X-200 VTOL prototype aircraft (AW June 20, p. 277) in favor of two turboshaft engines—either the General Electric T64 or the Lycoming T55. Company is having development problems with high power versions of the rotating combustion engine. Problems with multi-chamber units and inconsistent performance with larger single chamber engines are leading the company to concentrate on low horsepower, single-chamber powerplants.

► **Fairchild Engine & Airplane Corp. will build the Helio Super Courier STOL aircraft at its Hagerstown, Md., facility if sufficient military and civil orders develop. Super Courier has been demonstrated to Strategic Air Command at Warren AFB, Wyo., and SAC Headquarters, Omaha, Neb. SAC is interested in the aircraft for support work between missile emplacements.**

► Air Force, Army and Navy have designated 30 medical officers as Project Mercury aeromedical monitors. They will be based at global tracking stations to provide preflight and postflight analysis and medical care for the Mercury pilots.

► **Aeronutronic Division of Ford Motor Co. has completed preliminary design studies for the Project Ranger retrorocket, but has not fixed size, shape or thrust for the motor, which will be fired to permit an instrument package to survive a hard landing on the moon. Hercules-Allegany Ballistics Laboratory will build the rocket when the design is set. Ryan Aeronautical has a subcontract for a Ranger altimeter.**

► New Czechoslovakian helicopter, the HC-3, has been developed for use in agriculture, forestry and aerial photography. Based on the operational HC-2, the HC-3 has a 240 hp., six-cylinder M-108H engine and can carry 4-5 passengers. Flight duration is 5 hr., maximum hovering altitude is 3,000 ft., operating altitude is 12,000 ft. and maximum speed at 2,900 lb. gross weight is 100 mph.

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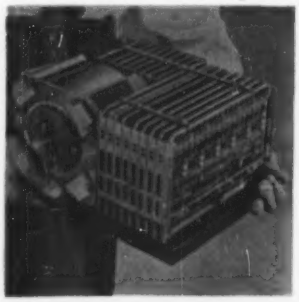

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GD LI 9-1

Washington Roundup

Labor Disputes Rapped

Air Force irritation at program delays caused by labor-management disputes was evident in a discusison of the problem by Vice Chief of Staff Gen. Curtis E. LeMay. A major source of this irritation has been disputes connected with ICBM base construction which have put them behind schedule. There also has been concern over labor troubles, including strikes, in the aircraft industry.

LeMay made a personal appeal to labor and management to re-evaluate their methods for solving disputes. He told the Convair-Ft. Worth Management Club that solutions must be found quickly to avoid delays that cut the operational life of a weapon system by postponing its introduction. He doesn't think all echelons of labor and management have been brought to understand the impact of disputes on defense programs.

ARDC Commander Lt. Gen. Bernard A. Schriever took the whole U. S. system to task last week, calling it a "bureaucracy of the worst kind." He didn't exclude the Air Force from his indictment. Congress was singled out for special criticism. Schriever said the legislative branch has assumed a bureaucratic role and must share the blame with the executive branch of government for delays, waste and inefficiency.

Civil Aeronautics Board staff is looking into a minimum rate for cargo shipments on Military Air Transport Command contracts. Air Force already has reluctantly accepted CAB's minimum of 2.9 cents per passenger mile for MATS traffic and rejected all bids based on lower rates.

Soviet Spy Scare

Soviet Union continues to press its contentions that the U. S. is spying on Russia from every angle. Tourists and other visitors are accused of espionage, and many are being expelled from the Soviet Union with great fanfare. This propaganda campaign continues in the wake of the U-2 incident to try to convince Soviet citizens of malevolent U. S. intentions.

U. S. intelligence has been accused of trying to use civil airlines for espionage. Soviets maintain the U. S. wants to install special reconnaissance equipment on airline transports flying over Russia.

Russians have taken the unusual step of publicizing a story that two "agents of a foreign power" tried to hijack an Aeroflot transport. Two passengers were reported to have boarded the airplane at an unidentified Baltic airport, probably Riga, at the last minute before takeoff. Soviets said they pulled guns on the pilot, but a mechanic blocked the escape attempt, losing his life in the process.

East Germans are blaming delays in introduction of their Type 152 medium-range jet transport on a spy. They claim an engineer secretly working for the West German intelligence service delayed development of the Pirna 0-14 turbojet engine for the Type 152 transport. East Germans are trying him as a spy. He is Manfred Gerlach, technical director of Veb Entwichklungsban at Pirna.

Indications of U. S. espionage problems arose last week when House Democratic leader John W. McCormack called for investigation of the disappearance of two National Security Agency employes. He believes they took valuable code information and a broad knowledge of U. S. code machinery with them to the Soviet Union. House Un-American Activities Committee is going to investigate.

Raborn Promotion

Polaris program director Rear Adm. William F. Raborn will soon be nominated for the rank of vice admiral, but he will remain in charge of the program. The promotion comes as a reward for compressing the program by three years since he took over in December, 1955.

Senate Armed Services Committee is sitting on 19 nominations for new admirals. Navy has a statutory quota of 306 admirals, but conservative promotion policy has held this to 287. Navy has 25% of its admirals in Defense Department posts, compared with 19% for Army generals and 16% for Air Force general officers. Situation will be further aggravated by the assignment of three admirals to the new Strategic Targeting Unit. Sen. John Stennis has objected to Navy attempts to fill its quota, and the committee is going along.

Hiring of retired military officers for civilian government jobs will be studied by a House Civil Service Committee group. Subcommittee headed by Rep. James Davis will conduct the study. Conflict-of-interest hearings last year before the House Armed Services Investigating Subcommittee showed that many retired officers would prefer to continue to work for the government in a civilian job rather than moving to industry. They are currently blocked by several impediments and penalties aimed at protecting the civil service career system and preventing those receiving pensions from getting other government income.

—Washington Staff

NASA Invites Industry Into New Market

Second-generation vehicles near contract stage; contractors to share 85% of Goddard's budget.

By Edward H. Kolcum

Washington—National Aeronautics and Space Administration invited industry last week to participate in a rapidly growing new market tied to the development of second generation space vehicles, including the Project Apollo manned spacecraft system.

In the second of four NASA-industry conferences, Goddard Space Flight Center assured industry that qualified companies will have an equal opportunity to compete for contracts in expanding spacecraft, satellite and sounding rocket programs which will cost $221.5 million in Fiscal 1961. NASA plans to contract 85% of this to industry.

Briefing series began in July with headquarters presentations on over-all NASA programs. Propulsion projects will be covered by Marshall Space Flight Center Sept. 27-28 at Huntsville, Ala., and Jet Propulsion Laboratory will discuss lunar and planetary programs Oct. 26 in Pasadena.

At the Goddard conference, Dr. Harry J. Goett, director, said that because of the 2-4 year lead times involved in space programs, procurement emphasis is shifting to second-generation systems. These systems are Apollo (AW Aug. 29, p. 26), Nimbus meteorological polar orbiter, orbiting astronomical observatory and orbiting geophysical observatory. They are just emerging from the initial NASA study stage and reaching the point where design contracts can be considered.

NASA will hold a Project Apollo conference Sept. 12 at Langley Field, Va., for prime contractors interested in bidding on a feasibility-design study of the program.

On the basis of proposals due Oct. 10, NASA expects to award two or three concurrent $250,000 contracts Nov. 14. These six-month contracts will call for completed reports by May 15.

Objectives of the fixed-fee contracts, to be awarded on the basis of approach and technical qualifications, are definition of a manned spacecraft system which will meet mission requirements, formulation of a program plan for implementation, identification of areas which require long lead times in research and development, and a cost analysis for the Apollo system.

Initial missions will be earth orbital to qualify the system for later circumlunar flight. NASA said early flights will be made to evaluate both crews and systems, train crews and develop operational procedures. More sophisticated earth orbital flights will follow to develop capabilities for rendezvous, assembly in orbit, refueling, orbital maneuvers and scientific experiments.

Apollo briefing team, headed by Robert R. Gilruth, director of Goddard Space Task Group, presented this outline for the coming Apollo study:

• **Return, re-entry and landing** requirements, including abort recovery, capabilities to avoid local hazards, land on ground or water in a small area and survive for at least 72 hr. after landing. Capsule must have on-board propulsion for maneuvers, with consideration for either parachute or glider landing systems. Propulsion rockets are to be flexible and able to provide multiple firings.

• **Demands for flight** in atmospheric, suborbital and superorbital regimes. Separation points in these regimes will be 180 sec. after launch at velocity of 4,480 mph. and 40 mi. altitude for atmospheric flight; 595 sec. at 17,470 mph. and 100 mi. altitude for suborbital flight; and 795 sec., 24,540 mph. and 131 mi. altitude for superorbital flight.

• **Aerodynamic considerations** in the areas of heating and loads, maneuvering capacities and configuration as they must be compromised for weight and design.

• **Variety of considerations** for a three-man crew which will work in a shirt-sleeve environment, protected from radiation. Physical environment will include atmospheric control, decompression, acceleration, noise and vibration protection, provision for nutrition and waste disposal, interior arrangement and displays, bio-instrumentation and provisions for working in zero gravity.

• **Systems requirements**, with retention on board of primary mission command. Vehicle systems will include inertial and optical navigation, computer and displays, and attitude and propulsion controls. Communications for orbital and lunar missions have a firm requirement for near-continuous voice and for continuous wave systems. Telemetry requirements will vary with the mission, and television could be included for lunar flights.

Tracking will be near-continuous for lunar flights, and trajectory fixes are required once each earth orbital period. Ground navigation fixes will be obtained mid-course in a lunar flight and just before the retrograde rocket is fired on an orbital mission.

Working under these general mission and systems definitions, industry will carry out studies concurrently with NASA research centers, which are now generating basic information in such

WADD Preparing B-70 Acceleration Plan

Washington—Detailed plans under which the Air Force-North American B-70 bomber will be reinstated as a weapon system are due to be sent to the Pentagon by Wright Air Development Division within a month. Basic agreement has been reached between the Air Force and the Administration's budget chiefs that $220 million may be spent out of Fiscal 1961 funds to implement this plan without further consultation. The new development plan calls for 11 flight test aircraft and one structures static test airframe.

Another $100 million is available if necessary to get the B-70 weapon system program rolling again after being cut back last December to a prototype project in which the only objective was to fly an aircraft at Mach 3. If these additional funds are needed, further consultation between the Air Force and Budget Bureau will be necessary to justify the expense. Air Force has made it clear to the B-70 Project Office at WADD and to all contractors on the aircraft and its systems that it does not want to be forced into this budget process and that the greatest effort is to be made to hold costs down.

Original Air Force request for B-70 funds in Fiscal 1961 was $365 million, but this was cut during budget reviews at Defense Department level. During final budget paring outside of the Defense Department, the B-70 funds were reduced to $75 million, and the aircraft's bombing-navigation, electronic countermeasures and mission and traffic control systems had to be canceled. Various estimates are being made on the slippage in B-70 operational date caused by the nine month delay in development which is about to end. If funding remains adequate, many Air Force officials believe that the original target date of 1965 for the first operational wing could be met. Predicted development cost for the B-70 plus the production funds for the first wing of 62 aircraft is estimated at $2.3 billion.

areas as trajectories, heating, guidance and structures. This information will be made available to contractors.

Robert R. Ziemer, orbiting astronomical observatory (OAO) manager, said development and prototype testing for this satellite will begin before the end of the year, with launches beginning in 1963. Experimenters so far are the University of Wisconsin, Smithsonian Astrophysical Observatory, Princeton University and NASA.

Orbiting geophysical observatory will have two missions, with polar orbiter called POGO and eccentric orbiter named EGO.

Geophysical satellite will be modular for rapid installation of experiments in the 1,000 lb. flight package. Wilfred E. Scull, project manager, identified subsystem design areas still open for consideration as the structural configuration, stabilization and control elements, thermal control systems, power sources, communications and data processing, and experiments.

POGO and EGO, Scull said, will be flown to monitor and diagnose energetic particles and to study ionospheres and plasmas, magnetic fields, astronomy, cosmic dust, pressures, densities as well as temperatures and radiation.

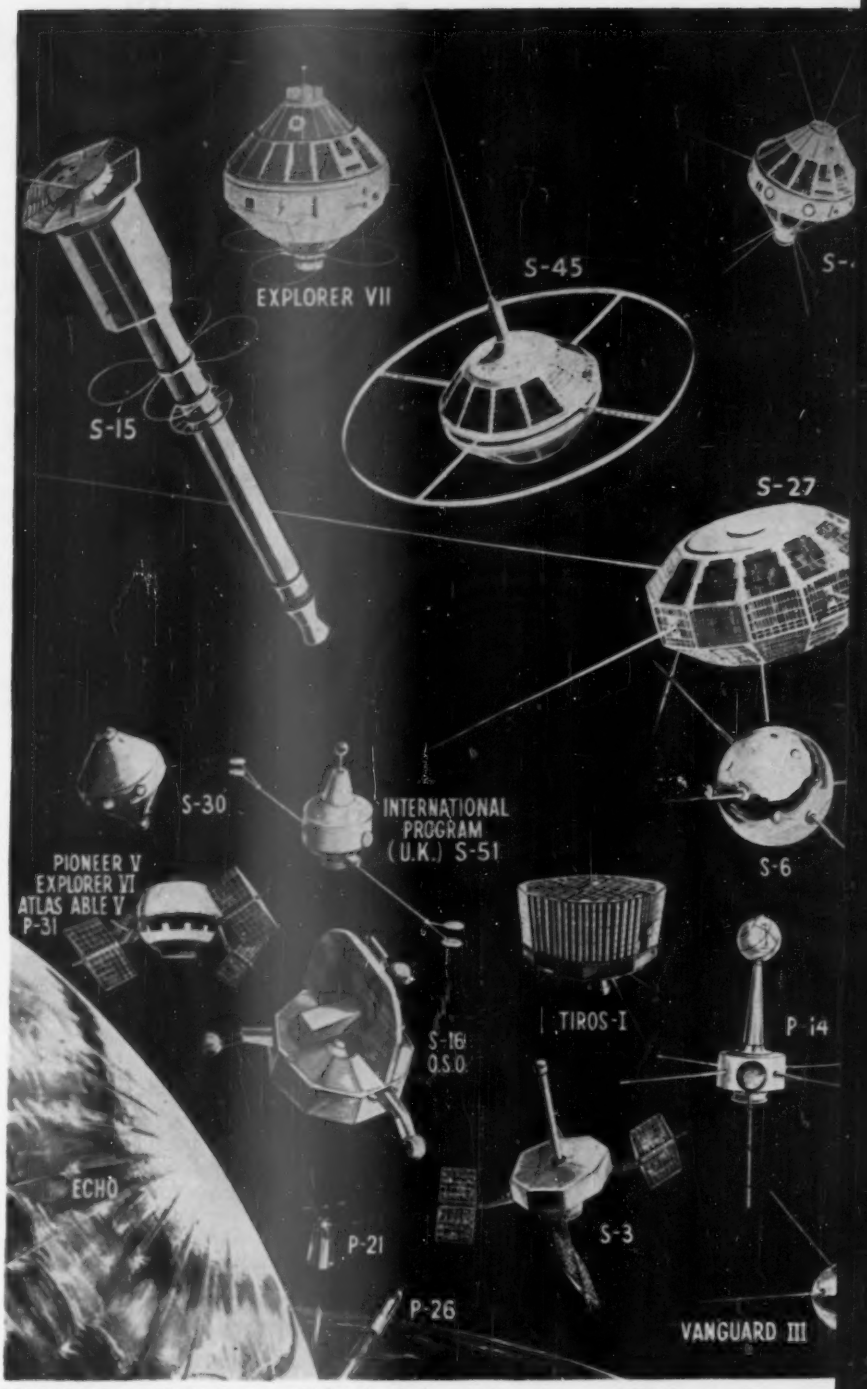
Systems contract will be awarded before the end of this year for delivery of elliptical orbiter prototype in mid-1962 and POGO prototype several months later. Launches are planned in 1963.

Second generation weather satellite, Nimbus, was described by Dr. Rudolph A. Stampfl who pointed out that it will be earth oriented and provide full video coverage along with infrared scanning.

J. T. Mengel, assistant director for tracking and data systems, told the conference systems developments are sought in improved data acquisition and reduction, in more precise tracking and computing and in wide band, long range communications. Mengel said $24.4 million will be spent this year for tracking and data systems, including $5.1 million for advanced developments.

Goddard also plans to spend $3 million for equipment and $9.65 million for construction this year, according to Leopold Winkler, technical services chief. Laboratory facilities will include four thermal vacuum chambers, centrifuges, dynamic balancing machines and vibrators.

Dr. Michael J. Vaccaro, assistant director for business administration, said Goddard's functional organization in four procurement areas, with a central industry contact, permits the center to conduct proposal reviews and approvals concurrently rather than sequentially. Harry O'Toole is the industry contact.



GODDARD Space Flight Center vehicles already launched are Vanguard III, Pioneer V, Explorer VI, Tiros and Echo. Others shown will investigate: particles (S-3); atmospheric structures (S-6); gamma rays (S-15); solar phenomena (S-16); topside of the ionosphere by Canada (S-27) and U. S. (S-48); ionosphere (S-30); and radiation, density and temperature, by Britain (S-51). Ionosphere beacon is S-45. Probe payloads are a magnetometer (P-14); electron density profile instrument (P-21); nuclear emulsion recovery vehicle (P-26), and lunar orbiter (P-31). These first generation space vehicles were described last week at National Aeronautics and Space Administration-industry conference, along with second generation systems. Spacecraft shown are funded for launch during coming two-year period. Major second generation projects ready for industrial contracts or study are Apollo, Nimbus, and orbiting astronomical and geophysical observatories. Only modestly funded in the current budget, these four projects are expected to receive heavy support in Fiscal 1962.

GE Developing 50,000 lb. Thrust Plug Nozzle Engine for Flight Test

Washington—General Electric Co. is developing a flight model of a 50,000 lb. thrust plug nozzle engine for National Aeronautics and Space Administration.

Plug nozzle development work, described in NASA's October 1959-March, 1960 report to Congress, is being conducted at GE's Malta Test Station, Schenectady, N. Y., where a state-of-the-art research program on plug nozzle engines with segmented combustion chambers was completed several months ago. Results showed that a short, truncated plug nozzle performed almost as efficiently as the longer, theoretically ideal nozzle.

Plug nozzle also proved to be a good steering system. Steering is done by varying the combustion pressure in the segmented combustion chambers which ring the plug. The research program provided data for designing future plug nozzles over wide operating ranges, the NASA report said.

Solid propellant rocket development work being undertaken now by NASA includes an investigation of a single 200 lb. sounding rocket combining the most modern design features, which will be able to go 40% higher than present rockets.

Solid rocket engine without a nozzle also is being investigated to see if the performance penalty will be more than offset by the lowering of cost and improvement in reliability.

End-burning propellant charges, abandoned for many years in high performance rockets, are also being studied for use in upper stage engines of very low weight.

In the materials area, electro-polishing of tungsten rods to remove the most minute surface scratches was found to increase their bend ductility sevenfold at room temperature in experiments at Lewis Research Center. NASA expects this technique to be of immediate benefit to organizations fabricating experimental shapes out of tungsten.

Development work with molybdenum at the Langley Research Center has shown that structural sandwiches of this material have acceptable mechanical properties at 3,000F and can be profitably used in construction of re-entry vehicles. The molybdenum tested was coated to protect it against oxidation.

Refractory ceramics are also being studied intensively by NASA. Hafnium carbide and tantalum carbide with melting points of 7,000F and above are being investigated to determine the effect of varying their carbon content and to try to obtain the highest density possible. A density of better than 98% has been achieved with hafnium carbide as compared with commercially available density of 80%. Materials in this melting point range are of interest for vehicles returning from the moon which will have to re-enter the atmosphere at escape speed of about 25,000 mph., compared with satellite speed of about 18,000 mph.

Structural studies for orbital space stations and vehicles have shown that those built with a double hull, with fiber glass filling the space between the hulls, would weigh only about one-third as much as a vehicle built with a single wall that gave equal protection against micrometeorites.

Analysis of complete vehicle structure, insulation and cooling systems have indicated that a water cooling system with coils running along the inside of an ablating skin can be used to materially reduce the structural weight of any high temperature vehicle.

Tactical Data System Designed for Fleet

Washington—Experimental version of the new Naval Tactical Data System, sometimes called "Shipboard SAGE" because of the similar functions of the two systems, currently is being tested at Naval Electronics Laboratory, San Diego. Fleet service test is scheduled for late next year.

The Naval Tactical Data System (NTDS) is intended to combine a far-flung fleet of aircraft carriers, missile ships and support vessels into an integrated weapon system for most effective use of the available weapons.

Like Air Force's ground-based SAGE system, the Navy's new NTDS includes computers, automatic situation displays and data links for transmitting target detection information to computers and displays. For NTDS, ultra-high-frequency and high-frequency radio is used for data communications, and target data comes from sonar as well as radar detection.

Information on location of enemy aircraft and submarines, as well as friendly vessels, can also be obtained from airborne early warning aircraft, as well as from task force surface vessels.

Each major ship in a task force will be outfitted with computers and automatic situation displays so it can function autonomously, if necessary. Navy AEW aircraft, outfitted with the Airborne Tactical Data System (ATDS) developed by Litton Industries, also will be able to serve as an independent command center. The airborne and ship-based systems will be able to interchange information automatically by means of data link.

Major contractors in the NTDS program include Remington Rand for the computers, Hughes Aircraft for situation displays and Collins Radio, which is supplying single sideband radio and data transmission equipment. Navy Bureau of Ships provides technical direction of the project.

Navy says the NTDS computes several possible deployments of available fleet weapons for use against attackers, leaving final choice of strategy up to fleet or ship commander. When weapon deployment and target assignment is determined, it is transmitted instantly by radio data link to other ships in the task force and to fleet aircraft. Presumably the NTDS computers, like those of SAGE centers, compute optimum flight path for fleet aircraft to reach their targets and transmit such data individually to each aircraft.

Structural Fatigue Life

Washington—Fatigue life of sheet metal structures may be predicted with "reasonable accuracy" through structural tests and simple theoretical procedures developed at the Langley Research Center according to the Third Semi-Annual National Aeronautics and Space Administration Report to the Congress. Structures tested by the new Langley method are subjected to much more complicated loadings than those used in the past in either static or dynamic ground tests.

Nuclear Plane Budget Approved by Congress

Washington—After considerable controversy, Congress last week approved $75 million for Atomic Energy Commission's Fiscal 1961 participation in the aircraft nuclear propulsion program—the full amount requested by AEC.

Department of Defense has already been appropriated $75 million for its half of the program.

Earlier, the House Appropriations Public Works Subcommittee eliminated all funds for AEC's ANP program. Subsequently, the Full House Appropriations Committee approved $58 million, and the Senate voted the $75 million.

The $75 million finally approved includes $41.5 million for the direct cycle reactor program of General Electric Co. and $27.5 million for the indirect cycle reactor program of Pratt & Whitney Division of United Aircraft.

Kennedy Creates Defense Planning Group

By Ford Eastman

Washington — Four-man committee to consult with defense and foreign policy experts of both parties and map a plan of action for the next Administration in the field of national security was created last week by Democratic presidential candidate Sen. John F. Kennedy.

Sen. Kennedy said the committee will not contribute ideas or assist in his campaign in any way unless a serious national crisis should arise which would require bipartisan action. Otherwise, he envisions the group's responsibility as a post-election effort to make sure that, if Kennedy is elected, the months of January, February and March will be used most effectively to launch changes and new programs.

Members of the committee are:

- **Roswell L. Gilpatric,** partner in Cravath, Swaine and Moore and chairman of the board of trustees of Aero-Space Corp., which is responsible for the technical supervision of future Air Force ballistic missile and space programs; Under Secretary of the Air Force from 1951 to 1953, and a member of the Rockefeller Special Studies Project from 1956 to 1957.
- **Paul H. Nitze** (chairman), president, Foreign Service Educational Foundation; vice chairman of the U. S. Strategic Bombing Survey from 1944 to 1946 and director of the State Department Policy Planning Staff from 1950 to 1953.
- **David K. E. Bruce,** U. S. Ambassador to France from 1949 to 1952; Under Secretary of State from 1952 to 1953, and U. S. Ambassador to Germany from 1957 to 1959.
- **James A. Perkins,** vice president of the Carnegie Corp., and a member of the Gaither Committee appointed by the President in 1957 to survey national security problems.

"This group," Sen. Kennedy said, "will consult on my behalf on national security problems with the ablest and most experienced authorities in the nation, without regard to party.

National Unity

"In this dangerous period, it is imperative that we maintain the highest national unity and the utmost responsibility in matters of national security at all times. I will be vigorously criticizing various aspects of current national security policies, but that criticism will be responsible and constructive," he said. "Both during the election and during the transfer of power from one administration to the next, we must demonstrate to the world that America is united, responsible, and alert—ready and able to meet any crisis that may arise.

"If we are successful in this election in November," Sen. Kennedy added, "the United States will be faced, and the incoming administration, with serious and heavy responsibilities in the field of national security. I think the work that this committee can do now in preparation for that period on a non-partisan basis will be most advantageous to the nation."

In the event the Democrats are not successful in November, Sen. Kennedy said he then would hope that the work of the committee would not have been in vain and that Vice President Richard Nixon, the Republican presidential candidate, might be interested in the judgments of the committee.

Some of the people the committee plans to consult, Nitze said, include: Robert C. Sprague, chairman of the Gaither Committee and member of a Nixon policy advisory group; William Foster, a member of the Gaither Committee; Dean Rusk of the Rockefeller Foundation; Dean Acheson, former Secretary of State in the Truman Administration; current and retired military officials and leading scientists who have been close to the national security program.

Sen. Kennedy said that, among other things, he would expect the committee to concern itself with the problems of nuclear testing during the post-election period, and if he were elected he would consult with the committee on budget requests that would be made for both the Defense Department and the State Department.

Appointment of the committee came on the heels of a speech Sen. Kennedy made at the Veterans of Foreign Wars convention in Detroit where he strongly criticized the Administration's defense and science policies and urged more effort in these fields.

"We are still the strongest power in the world today," he said. "But Communist power has been, and is now, growing faster than is our own. And by Communist power I mean military power, economic power, scientific and educational power and political power. They are moving faster than we are: on the ground, under the ocean, in the air and out in space."

Sen. Kennedy said he believed there is only one possible defense policy for the United States and that is to be first in military power across the board. "Only then can we stop the next war before it starts," he said. "Only then can we prevent war by preparing for it. Only then can we pave the way to disarmament by showing Mr. Khrushchev the futility of Russian armaments."

While all agree that the U. S. today is the most powerful nation on earth, the Democratic presidential candidate said, he questioned whether it would still be the greatest and most powerful in five to 10 years from now.

Rate of Progress Lags

"We are falling behind in our schedules, behind in our needs, behind the Russians in our rate of progress," he said. "The missile lag looms larger and larger ahead. Our Army and Marine Corps lack the manpower, the weapons and the jet airlift mobility to put out a brush fire war before it becomes a conflagration.

"We need to put our Strategic Air Command on an air alert and under wide dispersal—improve our systems of continental defense—step up our anti-submarine warfare effort—increase the thrust of our rocket engines—harden our missiles bases—and modernize our outdated Pentagon research, organization and weapons evaluation."

Sen. Kennedy told the VFW there is currently a dispute over whether the Administration should spend the additional defense funds voted by Congress for the current fiscal year and said his own position is that these funds must be unfrozen and spent.

AEC-NASA Office To Run Project Rover

Washington—Joint Atomic Energy Commission-National Aeronautics and Space Administration nuclear rocket propulsion office was established last week under management of NASA's Harold B. Finger.

Merger of nuclear propulsion efforts under Finger, predicted by AVIATION WEEK (AW May 9, p. 25), provides a single manager for development of Rover and other advanced nuclear rocket propulsion programs to be used in space vehicles. Finger will retain technical management for NASA over the Snap-8 project.

Joint office will be located at AEC headquarters in Germantown, Md., and will consist of approximately 15 employes from both agencies and the Air Force. Finger will report to Dr. Frank K. Pittman, director of AEC's division of reactor development. Deputy manager is Milton Klein of AEC.

AEC retains statutory responsibility for development of all nuclear reactors and components. NASA is responsible for non-nuclear components and for integration of reactors in rocket systems.

Companies Spar for Light Turbine Sales

Army competition for up to 4,000 light helicopters is catalyst in race for predominance and civil market.

By William H. Gregory

Engine manufacturers, the military, commercial operators, aircraft and helicopter manufacturers are reaching the showdown stages of a complex poker game whose unknowns are the future market for a light turbine engine and, if the market exists, for what power class.

Allison Division of General Motors has a strong hand with its 250 eshp. T63 engine partly sponsored by the Army and regarded as the leading competitor for choice in the Army's projected requirement for 3,500-4,000 light observation helicopters (AW May 9, p. 36).

Army has encouraged alternate proposals and Pratt & Whitney, Continental Aviation and Engineering Corp., and Boeing Airplane Co. are developing larger engines—in the 400-600 shp. class. These engines may emerge as dark horses in the Army competition and may also find a large potential civil market irrespective of who wins the Army business.

Some Components Built

Lycoming Division of Avco Corp. and General Electric's Small Aircraft Engine Dept. have studied or built some components in the 500 shp. class, but have not gone ahead with full development.

Garrett Corp.'s AiResearch Mfg. Co. has an engine family covering the 160-300 shp. range.

The situation is a turbulent, competitive one strewn with uncertainties because of these factors, a survey by AVIATION WEEK of manufacturers indicates:

• **Army order** would be a tremendous asset to the engine builder, enabling him to set up volume production and quote firm off-the-shelf prices to commercial customers. There is other military business, however; Navy's DASH anti-submarine program and a possible Marine Corps version of the Army light observation helicopter. Furthermore, there are many advanced V/STOL project that might eventually require engines in quantity.

• **Horsepower class** has become an increasingly debated point. Allison competitor's entry into the race underscores a growing belief that a 250 hp. engine will be hard put to fulfill the Army's mission and performance requirements for the light observation helicopter. Army is understood to be pressing the airframe manufacturers to hold to the 250 hp. engine in effect to force an advance in the state of the art and also because of fears that if the helicopter is allowed to grow it will hurt the cost picture. Relaxation of specifications might be a way out. For example the 100 kt. top speed requirement, theoretically possible with 250 hp., could be dropped to an attainable 70-90 kt.

• **Commercial turbine** engine use remains a big question mark. Major fixed wing business plane manufacturers are showing strong interest and at the same time strong skepticism. Beech has indicated interest in fitting its new Queen Air with turbine engines. Piper, on the other hand, has yet to be convinced a turbine engine is any improvement over a good piston engine—especially when the complicating necessity for pressurization and operation at high speed and altitude are introduced.

• **Commercial helicopter** operators are interested in turbine engines but feel they need detailed cost data before making any projections. Engine manufacturers, at the other pole, find it hard to quote firm prices without some orders in hand. Thus the importance of a major military order reappears.

This last dilemma was summed up late in August by J. C. Weadock, president of Chesapeake & Potomac Air-

Disposable Pod Increases Convair B-58 Performance

Two-component disposable pod is being produced for Air Force B-58 Hustler bomber by Convair Division of General Dynamics Corp. Lower portion of the pod can be jettisoned after the fuel it carries has been exhausted. Upper portion of the pod, which carries both fuel and the bomber's payload, would be dropped on target in combat (AW June 20, p. 124). Disposable pod improves B-58 performance since it reduces drag, giving both added speed and range.

ways, in his discussion at a regional meeting of the American Helicopter Society at Lynn, Mass., of the impact of turbine helicopters on charter operators.

Cost is the overriding consideration for the charter operator, Weadock said. Initial cost is vital, because the charter operator's one-man style operation limits his financial resources. So are operating cost details, particularly overhaul periods, degrees of skills required in turbine engine maintenance and whether there will be engine exchange programs like those for piston engines.

Information is becoming available on larger engines such as the GE T58 and Lycoming T53, but he doubted whether engines this large would be bought by operators in large quantity. Only 20% of all commercial helicopters in the U. S. are larger than 2-4 place machines, he said, and because of economics he doubted whether the ratio would change with the advent of turbines. This indicates an important market for the smaller turbine engine.

"Maybe some operators are postponing purchases, waiting to buy a turbine helicopter," he said. "But they can't get information to make a decision. I hope the manufacturers will publish some information."

Price Structure

Engine manufacturers are wary of discussing price, but seem to agree at least that a light commercial turbine will have to sell for under $10,000 or less than $20 a horsepower. Some feel the turbine will have to cost less than the comparable horsepower piston engine to compete.

Estimates of actual prices quoted in sales presentations run all the way from $18-$30 a horsepower.

Accessories present an unknown factor in this respect. Piper notes that piston engines are sold with fuel metering equipment, electric equipment, etc., as part of the price package but that prices quoted to it for turbine engines did not include accessories.

Beech, regarded as most likely to make the first move into turbines, feels engine makers are too nebulous about costs, which appear too high, to single out any one. Beech is watching the T63 because of the attack on manufacturing costs promised by Allison, using plastic compressor blades and other innovations, and is considering coupled versions.

Cessna Offer

Cessna offered a civil version of its twin-turbojet T-37A trainer, the Model 407, but did not find market interest strong.

Otherwise Cessna is being close-mouthed and keeping in touch with the state of the art. Cessna has been a traditional customer of Continental for piston engines.

Aero Design is thinking of going directly to turbojet designs and is looking with interest at light turbofans as the General Electric CF700F.

Turbine Applications

Fixed wing turbine application proposals run all the way from light twins on the order of the Cessna 310, Beech Travel Air and Piper Apache to relatively large aircraft in the $200,000-$500,000 class—that is, between the light twins and the Grumman Gulfstream or Lockheed JetStar class where prices run to $1 million or more.

Exactly when the first business plane manufacturer might reveal a light turbine engine configuration is debated. One engine company thought a move might be made at the National Business Aircraft Assn. convention Sept. 20-22. Others feel any decision will be much farther off. In general, certification plans are for late 1961 or 1962.

Another element is possible foreign competition, with price advantages because of lower labor costs. Two Beech conversions are flying in Europe (see p. 112).

At this stage, the engine people seem to be more concerned about whether business plane makers will get into turbines at all rather than what the competition will be.

Program Status

The status of various programs in brief:

• **Allison.** Completion of the 150 hr. military test program is scheduled for the fall of 1961 with partial Army funding to carry through until then. Allison is proposing a coupled version of the T63 as an entry in the 500 hp. class but faces the question of whether this would result in component duplication and added weight; T63 turboprop version weight is quoted at 110 lb., turboshaft 95 lb. Allison says it is 18 months away from quoting off-the-shelf prices. Allison has an engine running, but will concentrate on completing the military test program before getting into FAA certification.

• **Boeing.** Two families of engines—the 502 and 520 series—are in development, but Boeing is placing most long range stock in the 520 series in the 400-600 shp. range. Boeing has orders for 40 T50 engines (502 series) for the Navy DASH program to go in the Gyrodyne drone helicopter and has Navy funding for the T60 engine (430 shp. in the 520 series) through its 50 hr. qualification test. Weight has been a competitive drawback for this engine, but Boeing has an advanced version with weight cut from 325 lb. to 215 lb. Test engines in the T60 series will be available in early 1962, and Boeing expects to apply for FAA certification.

• **Continental.** Newest entry in the 500 hp. field, Continental's 217 engine has a two stage combination axial-centrifugal compressor with a two-stage axial turbine to drive the compressor and a single stage power turbine. The 217-5A turboshaft weight is quoted at 210 lb. and 217-6A turboprop at 230 lb.

Continental has done most of its component work and expects to have an engine running in October. It has had preliminary discussions with light aircraft manufacturers and is talking in terms of delivery in the spring of 1961. Market surveys have convinced Continental the 500-600 hp. class offers the best potential, and it covers a broad range with its own designs and those licensed from the French manufacturer, Turbomeca.

• **Pratt & Whitney.** Five engines are running in test cells at Canadian Pratt & Whitney and a Beech Model 18 is being modified to carry the engine in its nose as a testbed. Flight tests are to begin in January. Pratt & Whitney is talking delivery in spring or summer of 1962. Both fixed wing and helicopter manufacturers have been discussing the engine with the company. One has been sold to Cooper-Bessemer for an industrial application.

Lycoming and AiResearch feel there is growing interest in the 500 hp. area. In the case of Lycoming, this company questions whether there will be a large enough commercial market to warrant a multimillion dollar development program. It also has its T53-L1 helicopter engine certificated and its -L3 turboprop well on the way to certification and it feels faster availability of the engine, even though it is in the 1,000 shp. class, might be a consideration. AiResearch, which bid with Curtiss-Wright for the 250 hp. engine contract, now is interested in industrial applications for its engines.

Nuclear Ramjet Testing

Specifications for the nuclear ramjet test facility at Jackass Flats, Nev., call for storage of 1.5 million lb. of air compressed to 3,500 psi. Ultimate plan calls for trebling air storage capacity to permit sustained runs of up to 30 min. With presently projected facilities, air is to be delivered to the engine inlet at 1,100F. at the rate of 2,500 lb./sec. and at a pressure of 600 psi. A major problem is in heating the air to the proper inlet temperature after expansion from 3,500 psi. as ambient temperature cools it to minus 100F.

Storage of air probably will be in a series of large pipes of 30 in. inside diameter with 1.5 in. walls. About 40,000 ft. of pipe will be needed.

Army Presses Nerve Gas Development

By Herbert J. Coleman

Dugway Proving Ground, Utah—Nerve gases capable of killing or mass incapacitation are under development here by U.S. Army as a result of what it considers a clear and present danger that the Russians have as much capability, if not more.

Dugway, 75 mi. west of Salt Lake City in a remote desert area, is home to 3,000 civilian and military personnel working on various projects in what Brig. Gen. Fred J. Delmore, commander, Chemical Corps Research and Development Command, said is not a crash program, but a slow, steady effort.

This was the first time Army has publicly opened its nerve gas facility. Officials said the move was necessary for "full public awareness of the need for chemical warfare defense and possible retaliation."

Along with actual gas development, Army is intensively working on defense and delivery systems. The gases could be delivered by:

- **Sergeant surface-to-surface missile**, trapped in small aluminum balls in the warhead. Air would react on the gases, releasing fumes through holes in the balls, either by radio command in the air, or at impact.
- **Honest John Missile**, using much the same method as Sergeant.
- **Aircraft spray tanks**, hung on jet aircraft for low altitude sweeps across a target area. Gas could be contained in the balls, or in internal tankage with fumes released from the tail cone.
- **Intercontinental ballistic missiles**, but this is a method that Gen. Delmore hedged saying "anything is possible in an ICBM."

Army is understandably concerned about public reaction to its nerve gases and is fully aware of the social, political and moral aspects of this type of warfare. It already has had its troubles with U. S. Department of State, various NATO nations, and the Society for Prevention of Cruelty to Animals.

Animal Tests

Various laboratories here are working on chemical, biological and radiological aspects of offensive and defensive warfare. Lethal gas used in mountain tests against tethered animals (goats and pigeons) is called Sarin (GB), for German Type B, four times as lethal as a gas known to be available to the Russians, called Tabun (GA), German Type A. Russians moved the entire Tabun plant from Germany to Russia in World War II.

These particular gases can kill before humans can detect their presence. They travel via the lungs, but a droplet can penetrate the skin and strike at the nerve ends, reacting with cholinesterase so that signals from the brain to muscles are disrupted. Symptoms are hard breathing, vomiting, cramps, involuntary elimination and then convulsions leading to death.

In a demonstration at Dugway's CBR Weapons Orientation Course auditorium, a rabbit lasted just 1 min. 10 sec. Goats died as fast in dugouts specially built at Wig Mountain, about 26 mi. away from the main Dugway administrative area.

Scientists here also are concentrating on an incapacitating agent, although they will not say what it is, other than to describe one gas as a "research agent discovered while searching for a better pain killer than morphine."

Using a dog of uncertain ancestry named Sparky, the gas was introduced into a glass cage, paralyzing the dog within seconds. There was no pain involved and the dog remained conscious; paralysis could continue for about 3 to 4 hr. if no antidote was administered. In Sparky's case, the antidote reaction was given by injection and reaction was startling—he was on his feet almost immediately.

Riot Gas

Another, less vital, area of research is an anti-riot gas called CS. Volunteers who walked through a cloud of CS, sans gas mask, found the reaction was streaming eyes, wrenching coughs and a warmth empathy with the late goats and pigeons.

Still under development, but being readied for operation this winter, is the radiological test grid located in an especially remote section of Dugway. It is a large octagonal concrete emplacement, surrounded by earthen walls, and will be used to test aircraft and ground vehicle shielding.

The contaminant, radioactive cobalt with a half life of 10 years, will be contained in tear-droplet slugs made of high chrome alloy and Type 446 stainless steel. The droplets are being made under contract by the University of Utah.

Scientists said they will be spread over the 200 yard diameter concrete area, raising a radioactive field about 2 ft. above the surface. Initially, shielded tanks all highly instrumented, will be driven into the area by remote control to test radioactive results. Remote handling devices, a forklift and tractor, also will be used here. Dose rate will be 10 roentgens per hour.

Test results will be analyzed at a nearby radiological laboratory set up and operated by the university.

Underground Cables

To test various regimes, Dugway has installed a system of cables laid under the cement surface which will emit pulses to reception units in the tanks, guiding them to areas of various radioactive strength. This is because Dugway scientists can create skip distances and hot spots by proper emplacement of the radioactive droplets, for higher doses of radiation.

The test facility was deliberately constructed with a 3 ft. slant in flooring, to allow the droplets to be washed into catch basins and recovered by remote handling devices.

Dugway is dotted with grids on which are placed various sampling devices, some electronic and some mechanical, to trap gases and particles used in tests, for laboratory analysis. In addition, according to Dr. M. A. Rothenberg, chief scientist, Dugway maintains eight field telemetry stations for weather data, all-important in this critical field.

One man is employed as a full time trapper to obtain local wild life rodents, which range from rats and squirrels to skunks. These are used in laboratory tests, primarily to see if any agents developed at Dugway could be passed from animal to animal in the desert and mountains. It is, as Dr. Jack Palmer put it, "a constant check on our local population."

Dugway has only 12 families, not connected with the operation, living near its borders, and no incidents have been reported. Dugway's 1,300 sq. mi. are completely fenced in and patrolled daily by L-19 observation aircraft.

There has, however, been one case of a lethal contaminant striking at humans, near the Wig Mountain test site. Col. Joseph C. Prentice, CBR Weapons Orientation Course director,

Pay Cuts Restored

Douglas Aircraft Co. will restore all company salaried pay cuts retroactive to the time they took effect last Apr. 11. An arbitrator's decision was made last week that the company should restore salary cuts of members of the Southern California Professional Engineering Assn. who had filed grievances under terms of their contract with the company. Although the decision applied only to members of the association, the company felt that it could not in fairness not restore the pay cut to all salaried employes.

said a number of artillerymen were contaminated when a freak wind shift pushed a portion of a GB cloud in their direction after a firing on the Wig Mountain site and reached the site before the men could don masks. There were no serious results, Prentice said, and added: "most were up and around the next day."

The Wig Mountain test site consists of a two-man dugout, a hasty shelter, an open machine gun nest, an M-1 tank (as yet uninstrumented) and a command post. A scanning closed circuit television camera, shielded against fragments, overlooks the general area.

For this particular test, four tethered goats and four caged pigeons were placed in the dugouts and in the open machine gun nest. About 600 yards away was a battery of 155 mm. howitzers which fired shells loaded with the GB agent, contained in a brass tube about 1 ft. long.

Some distance away, at the CBR observation post, the scene could be safely watched on banks of television monitors, one for each position. Observer was equipped with an M-7 mask (aerosol filter) in case of a wind shift.

About 10 sec. after impact of a six-shell volley, the goat in the open area was dead. Gas swept into the hasty shelter, and the goat and pigeon there died almost immediately, with few convulsions. In the comparatively tight command post, one goat was fitted with a gas mask and another was not. The unmasked goat died about 45 sec. after shell impact. The masked goat, in effect, committed suicide some time later by tearing his mask loose from its connection. Convulsions, in this case, were marked, probably because the heavy gas concentration had deteriorated.

Col. Prentice said the mask for the command post goat was not turned on remotely until about 15 sec. after the shot—this is about the time a human would need to don a mask. There were no apparent effects visible on television, but a laboratory test probably would show a contraction of the corneas and a reduction in total vision.

Gen. Delmore said that 14 rounds of GB could produce lethality in a 100 sq. meter area, on a 75F day in which temperatures were neutral (against lapsed or inverted). Nine rounds of the incapacitating agent could fell the population in that area.

Chemical or biological warfare agents would be disseminated by a cloud, which Army scientists emphasized is odorless and colorless.

Possible effects of such a cloud are staggering. For instance, a Boeing B-52 jet bomber (or its equivalent) could carry enough chemical or biological agent to immobilize a 100 sq. mi. area, in case of the chemicals, or a 34,000 sq. mi. area with the biological agent, and with only 450 lb. of the agent.

The chemical agents could knock out 30% of the population (not necessarily lethal) and the biological agent would react on 25% to 75% of the population in its area.

It is significant that there would be no property damage in these areas; the chemicals would react in 7 sec. to 30 min. and biologicals in a few to 14 days. U.S. defense in both cases is nearly non-existent, although the U.S. Army Chemical Corps has developed masks and is working on advanced detection devices.

There is a prime necessity for public awareness of these agents—and in the military services themselves—particularly in the non-lethal field, according to Dr. Richard S. Morse, Army's director of research and development, who was here for the demonstration.

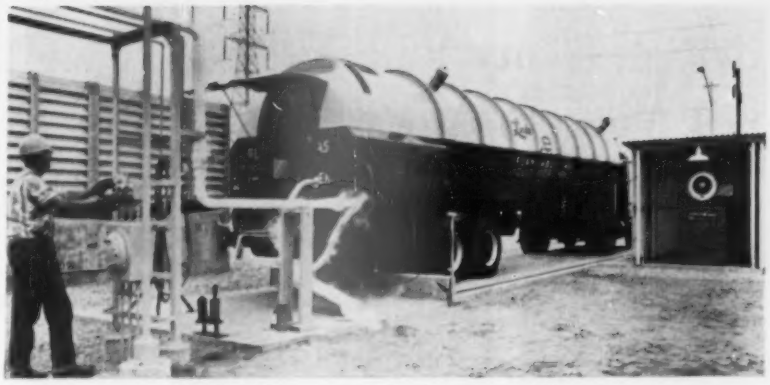
Army, he stressed, is "not looking for money. We don't need any more." Morse said last year's program cost $40 million and "this has been expanded with the Fiscal 1961 and 1962 budgets going up, not in a crash program but at an orderly rate."

There is, he continued, an abhorrence at use of CBR weapons "even among our military," but Morse underscored that this form of warfare now is a "real threat to the security of the U.S. and it calls for inter-service cooperation."

The Russians, he recalled, accused the U.S. of using biological warfare in Korea, and said this was a lie, but added: "we lost ground, particularly in the non-white areas . . . This is dirty pool and they are good at it.

"This country is not going to use biological warfare first," Morse said. "But we must be ready with that agent, chemical warfare and possibly radiological warfare agents."

Morse contended the U.S. should not rely entirely on Strategic Air Command as the major deterrent to war, but should have the chemical agents ready for effective use. This in itself, he indicated, is a great deterrent.



Linde Opens Hydrogen Plant

Operator loads liquid hydrogen into 7,800-gal. truck trailer on weighing platform at Linde Co.'s new liquid hydrogen plant in Torrance, Calif. Hydrogen vapor is vented through frost-covered line at right. Plant was designed and constructed by Linde, a division of Union Carbide, to supply NASA with up to 3.3 million lb. a year of liquid hydrogen under a contract awarded April, 1959. Total capacity of the plant is 4.3 million lb. a year.

Boeing Designs Twin Jet Tactical Fighter

Seattle—A supersonic twin jet tactical fighter featuring variable sweep wings will be proposed to the Air Force by the Boeing Aero-Space Division this fall. Boeing has been working on the design for two and one half years in anticipation of requirements for such a tactical aircraft useful in "brush-fire" emergencies.

Boeing is one of several aircraft manufacturers preparing designs for an Air Force competition to select a supersonic, low level attack aircraft with intercontinental range. It is to have short take-off capability and be able to fly faster than Mach 2 at high altitudes and Mach 1.2 at sea level. Originally set for last spring, the competition is set to open in mid-October.

Although configuration of the Boeing variable sweep aircraft is not final, it probably will be a two-place, tandem set design slightly larger than present operational fighters. Two turbojet or turbofan engines in the 15,000 lb. thrust category will power the aircraft at a maximum speed in excess of Mach 2, with supersonic capability at both high and low altitude. Boeing is also considering proposing a fixed-wing aircraft to meet this requirement.

The variable sweep wings will form a modified delta shape spanning 33 ft. for supersonic cruise and will span 67 ft. when brought forward for low speed flight. The wing arrangement will allow the fighter to operate effectively under short field conditions, Boeing claims.

British Army Places First Order For Vickers Anti-Tank Missile

London—First order for Vickers Vigilant anti-tank missiles has been placed with Vickers Armstrongs (Aircraft), Ltd., of Weybridge, by the British War Office for assessment trials by the British army. Estimates put the procurement figure at around 200 to 300.

Development of the wire-guided Vigilant, started three years ago as a private venture, has been completed for less than $2.8 million, with over 100 development rounds fired.

Vickers now is programing a sales effort both in NATO countries and the U.S. Italy is a probable first customer. In the U.S., Clevite Corp. as Vickers agent is pushing for trials with the U. S. Marine Corps. Vigilant has already had development firing trials for the U. S. Army.

Other advantages to Vigilant, according to Brig. J. Clemow, chief of Vickers Guided Weapons Division, are:

- **Portability** with a gross weight of less than 45 lb. and a warhead occupying 33% of the payload.
- **Wing span** less than 12 in. with a total length of 35 in.
- **Range up to 1 mi.** with plus or minus 30 deg. angular deviation.
- **No ground computing control.** The infantryman requires a pistol grip trigger with a thumb operated guidance system.
- **No warmup time,** due to transistorization.
- **Use of velocity control** closed loop containing two gyros gives missile attitude information and increased accuracy, including restoration to original course after deviation by wind gusts.

The missile is divided into four main sections, the warhead, gyro, motor and wire reel-out. The warhead is 5.16 in. in diameter and 15 in. long and fitted with a hollow charge. Explosive will penetrate the thickest armor of any known tank, Vickers says. An impact percussion cap detonates the explosive charge.

The gyro assembly containing two gyros is initially run up to speed within 0.3 sec. and uncaged before the missile has left its launching frame.

Propulsive power is from an I.C.I. solid propellant motor manufactured under license from Hercules Corp. Weight of the motor is around 8 lb. and it gives the missile a maximum speed of 450 fps. Motor design gives a compromise between slow speed build-up to allow adequate control time for close targets and the high speed required for long range work.

Aerodynamic control of the missile is from four trailing edge control surfaces made of glass cloth filled with foam plastic. Operation of the control surfaces is from a comparison of the demand signal on the wire with the gyro position. The resultant d.c. error voltage is converted to mechanical rotation and operates actuator valves. Power actuation is from a high pressure supply taken from a bleed on the motor unit itself. All avionics, comprising some forty transistors, are housed on printed circuits in moulded fairings attached to the outer case of the weapon. A turbo alternator driven from the motor bleed provides the necessary power.

Simplicity of the Vigilant lies in its launching technique. Available in a paradrop canister, the canister provides the launching ramp. For portable handling the weapon is housed in a waterproof bag with a small tubular frame launching tripod. Set up and firing time is as little as 20 sec.

Guidance is by a simple optical line of sight command system and the only prefiring setting up is plugging the pistol grip cable into the launching unit. Steering is by a thumb-operated lever in conjunction with a monocular sight to bring the missile onto target. Commands to the missile are transmitted via a wire wound on a spool encircling the rocket motor nozzle. Cost of the Vigilant when in production is estimated to be around $900 per missile.

Short Bros. Builds Skyvan Prototypes

Short Bros. & Harland, Belfast, is building a light, twin-engine general purpose air freighter designated the SC.7 Skyvan aimed at design simplicity and low cost to operators.

Rugged design which features a fixed undercarriage, braced high-aspect ratio wing and an unpressurized square fuselage section results from design considerations to optimize the aircraft around a cruising speed of 160 mph. at low altitudes (ceiling 20,000 ft.), a maximum payload of 3,360 lb. and full load range of 200 mi.

The aircraft is being offered fully equipped with IFR radio and navigational aids for $154,000, approximately $30 per lb. empty weight. Cost per ton mile figures for the Skyvan will work out at 27 cents over a 300-mi. range, the company estimates.

First of two prototypes from an initial batch of 25 aircraft is scheduled to fly next summer, and the aircraft should be in service twelve months later.

American equipment on the Skyvan includes Continental engines, Hartzell constant speed, fully feathering propellers, and radio and navigational equipment by Collins and Wilcox.

The little air-Jeep will be powered by two Continental GTS 10-520 six cylinder engines developing 390 hp. each, which together with the docile wing characteristics gives the aircraft a notably comfortable single engine performance. Stalling speed is 55 kt.

Main structural feature centers on the extensive use of reduxing in primary structure. Wing and fuselage skins consist of a flat outer plate reduxed to a corrugated inner plate, the corrugations forming the stringers. Frames and ribs are widely spaced at 20 and 12 in. respectively, and the joining of the skin to these members represents the only use of rivets in the aircraft.

The panels are bonded in very large units with unbroken strips running from root to tip on the inner wing skin and from the leading to trailing edge on the outer skin to allow for varying gage plate spanwise. Unbroken nose to tail strips are also used to cover the fuselage.

Advantages of a safe-life rather than a fail safe structure for this type of aircraft were stressed by chief designer Frank Robertson. He told Aviation Week that it was this philosophy which dictated the extensive use of reduxing used in the design because of the superior fatigue characteristics it bestows on a structure for a given weight. It also saves weight, which more than compensates for the small weight and drag penalties inherent in the fuselage shape. It has a very high wetted surface for its capacity.

According to Robertson, the strutted wing represents the best compromise between structural weight and drag considerations for an aircraft operating at the speeds and altitudes of the Skyvan. Besides freighting, Short Bros. sees the aircraft operating in roles which include:

- **Commuter aircraft** with 15-seat accommodation at 38-in. pitch with provisions for bar and toilet.
- **Executive transport.**
- **Flying showroom.**
- **Crop sprayer.**
- **Supply dropper,** paratrooping and air ambulance.

The square fuselage of the Skyvan simplifies the engineering of a large rear freight loading door, which is raised manually. Freight floor of the aircraft is only 26 in. off the ground.

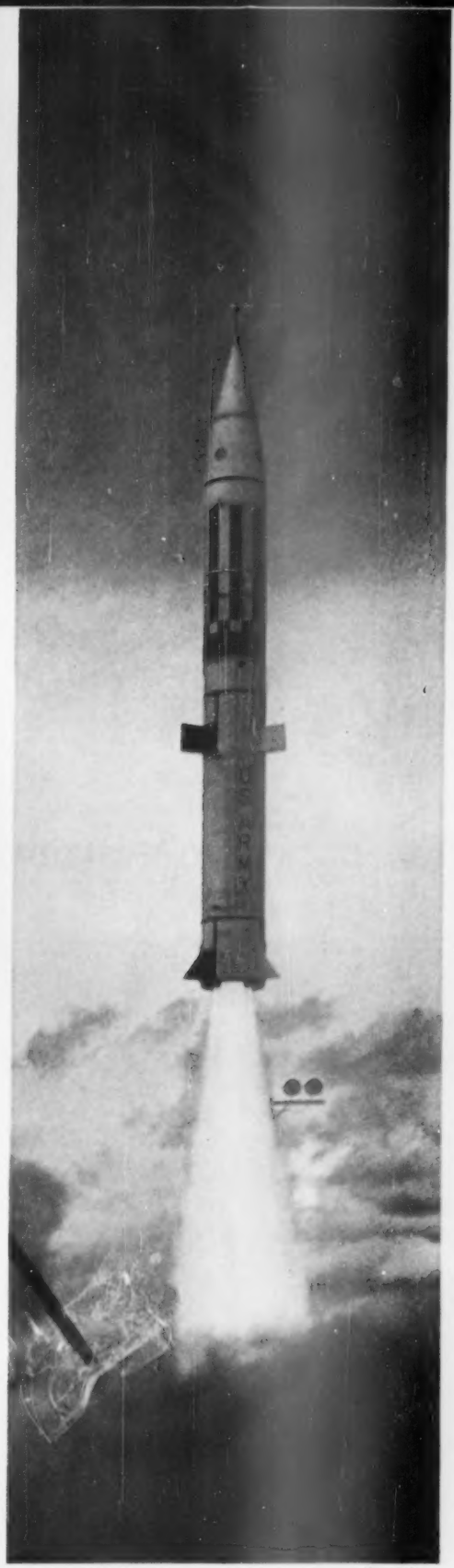
Unusual wing geometry stems from other fundamental optimization studies involving span, area, taper, section weight and general configuration. It has a parallel chord, aspect ratio 11 and 14% thick NACA 634-614 laminar flow aerofoil section, lift coefficient 0.6. Wing loading is approximately 23 psf.

Outer section of three single slotted flaps on each wing acts as the aileron.

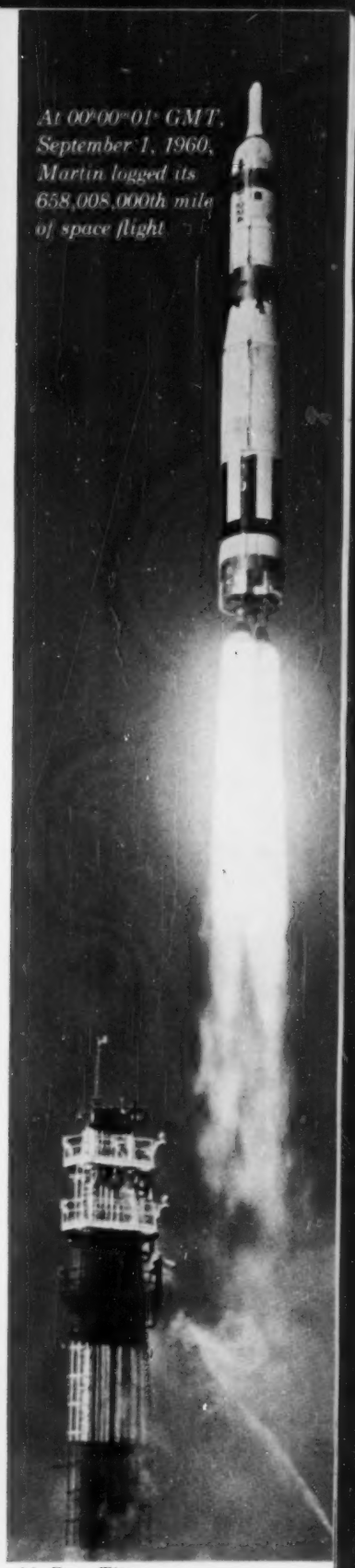
Navy & Air Force Bullpup

Air Force Mace

Army Lacrosse



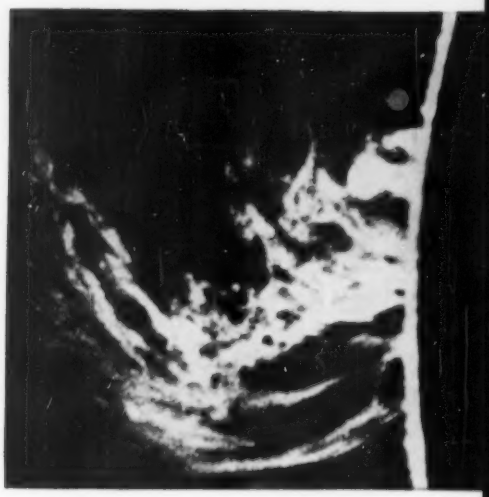
Army Pershing



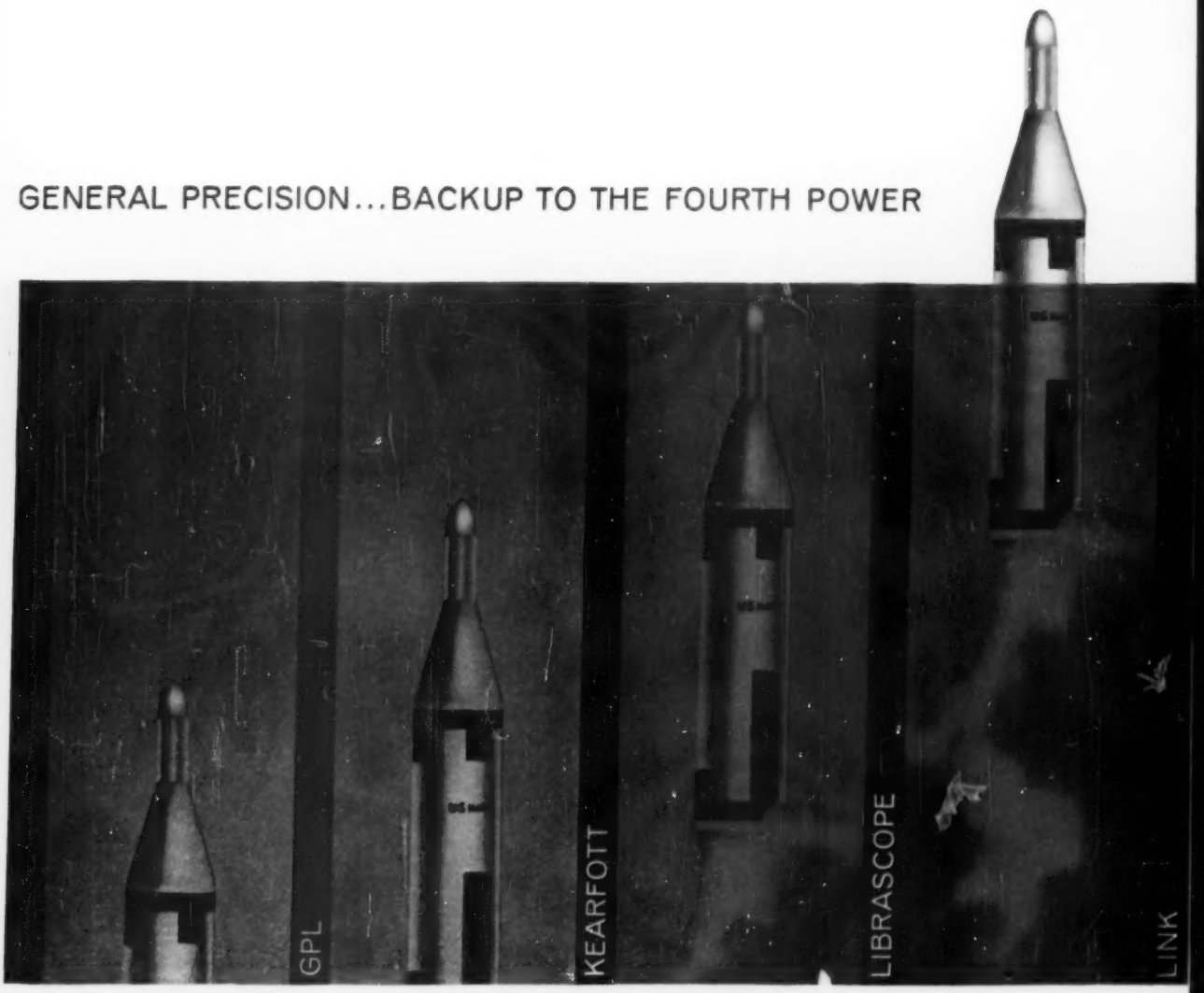
Air Force Titan

Five major U.S. missiles developed and built by Martin

MARTIN



GENERAL PRECISION...BACKUP TO THE FOURTH POWER



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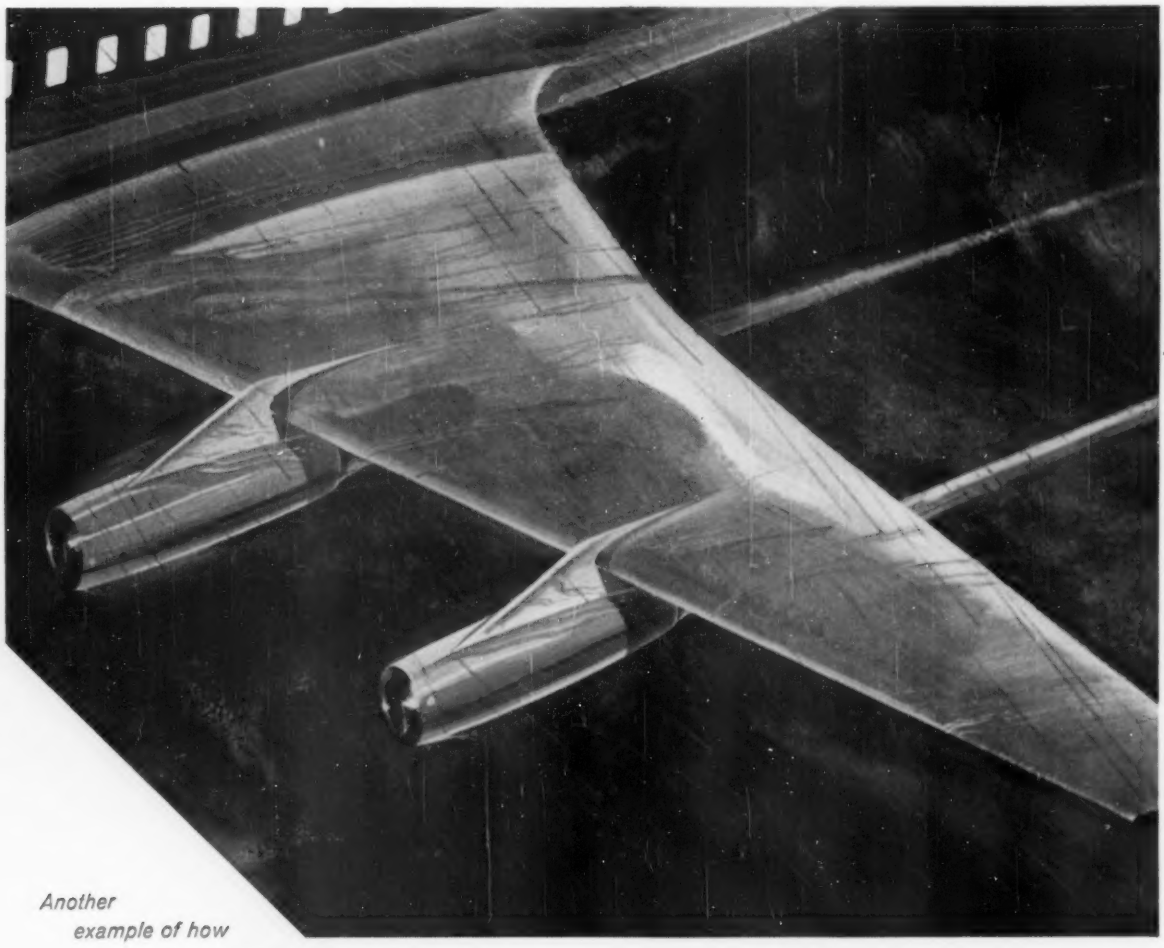

Another example of how

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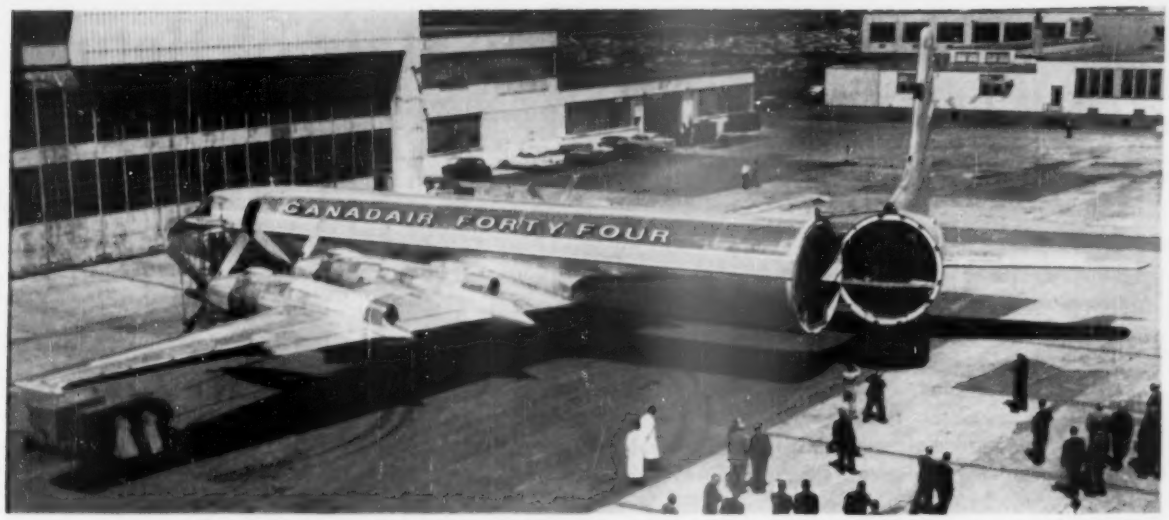


First Swing-Tail Canadair CL-44 Freighter Rolls Out

First of 17 turboprop swing-tail Canadair CL-44 freighters ordered by U. S. carriers for 1961 service is rolled out at Montreal. The transport is powered by four Rolls-Royce Tyne two-spool turboprop engines rated at 5,730 eshp. each at 15,250 rpm. at sea level. Flying Tiger Line has ordered 10 CL-44s, Seaboard & Western 5, and Slick Airways 2. Total cost of Slick's aircraft, to be delivered in September and October, 1961, will be $11,200,000, including spare engines and parts. Aircraft is 136 ft. 9.9 in. long.

USAF Tapers Off Congo Airlift

Wiesbaden, Germany—U. S. Air Force last week conducted a two-way Congo shuttle, carrying United Nations troops into the besieged republic and pulling Belgian troops out.

Using a total of 15 Douglas C-124 cargo aircraft of Military Air Transport Service and eight Lockheed C-130 turboprop transports of the 322nd Air Division, headquartered at Evreux Air Base, France, USAF ferried 1,323 Belgian troops from the Congo to Brussels as part of that nation's final military evacuation efforts. Major evacuation points were Elisabethville, capital of Katanga Province which has proclaimed its independence from Congo Republic, and Kamina, former Belgian military base which also is located in Katanga.

Present Commitments

USAF hopes to round out all but one of its present commitments to ferry troops into the Congo at United Nations request early this week when the last of 117 Canadian troops and 200 tons of equipment are offloaded after flights from Toronto in 14 MATS C-124s.

Lone untended commitment still resting on books of U.S. Air Force's headquarters in Europe here late last week called for transport of 600 Guinean troops from Conakry to Coquilhatville in the Congo. Originally scheduled to begin on Aug. 16, the airlift was delayed at the request of the government of Guinea because of unavailability of troops. New request to begin airlift had not been received by late last week but USAF officials were keeping aircraft available in the event it came through.

Finale of the present airlift effort was marred on Aug. 27 when eight crewmen of two MATS C-124s and two Canadian soldiers accompanying the aircraft were attacked by Congolese troops shortly after landing at Stanleyville. The crewmen, who were severely beaten before their rescue by Ethiopian troops of the United Nations force, were subsequently transferred to USAFE's Wiesbaden hospital for treatment and observation.

If no new projects are requested by United Nations, USAF this week will begin a gradual phaseout of the MATS two-squadron C-124 provisional wing headquartered at Chateauroux Air Base, France, which was hastily assembled in mid-July from U.S.-based units to supplement efforts of the 322nd Air Division's C-130s and C-124s of MATS' rotational squadron assigned to USAFE.

News Digest

NASA Langley Research Center and MIT Lincoln Labs last week launched sixth and seventh six-stage Trailblazer rockets with 5-in. spherical motor as last stage in basic research program on re-entry dynamics.

Tattle Tale emergency communications system was fired to an altitude of 300 mi. from Eglin AFB last week in a test of a system designed by Wright Air Development Division and built by Hughes Aircraft Co. It would replace destroyed ground communications in an attack. Signals were received at ground stations and in a WADD aircraft during the test.

Air Force-Martin Titan J-5 flew 5,000 mi. down the Atlantic Missile Range last week in the second successful test in a series of four launches with the operational J version. Nose cone was not recovered from the high trajectory test, which imposed more severe re-entry conditions than usual.

Wright A. Parkins, United Aircraft Corp. vice president and board member, last week announced his retirement and United named Erle Martin to the new position of vice president for research and development. Martin has directed operations at Hamilton Standard and Norden Divisions for the past two years. Parkins will continue to serve United as a consultant.

Dr. Wallace R. Brode retires tomorrow as State Department science adviser after three-year tenure in which he revived U. S. science attache program. Successor is Dr. Walter G. Whitman, on leave from Massachusetts Institute of Technology.

North American Aviation and Air Force Flight Test Center have conducted a thrust augmentation flight program at Edwards AFB, Calif., to measure the benefits of coupling Hound Dog missile turbojet power with that of the Boeing B-52 launch plane to reduce plane's takeoff roll.

Local Airlines Object to Rate of Return

Board decision outlines sliding scale approach; carriers say profit will fall below present level.

By Robert H. Cook

Washington—Local airlines are planning an all-out attack against a Civil Aeronautics Board decision permitting them a 9-12.75% rate of return but employing debt ratio limits which the carriers claim will actually drop their rate of return below the present 9.5% standard.

CAB's final decision in the four-year-old Rate of Return Local Service Carriers Investigation came as a complete surprise to the industry, since a June press release announcing the Board's tentative vote indicated that the 12.75% rate would be applied across-the-board. This would have given the local airlines a substantial increase over the current standard.

Local airlines have urged the Board to give them a fixed rate of return, and they plan to fight the sliding scale approach CAB now is taking. The carriers will file exceptions and press for an oral argument on the rate issue. They object to use of a sliding scale which would produce rates of return less than 12.75%, and they want to know whether CAB is going to consider convertible subordinated debentures debt or equity. They also want to know what progress the Board is making toward placing all local airlines on final mail rates under the new formula by the end of the year.

Last week the Board explained that it will allow return on debt of 5.5% and on equity of 21.35% in figuring the over-all rate of return. A carrier with a debt equity ratio of about 50% could get the maximum 12.75% rate of return. But most of the carriers have debt ratios much higher than this.

Since debt ratios vary among the airlines, the Board will deal with each case individually to determine rate of return. But in any case, the carriers will be allowed the higher equity return only on their actual equity base, not on a uniform industry-wide pattern as was previously assumed. Thus, carriers with high debt ratios will have most of their return based on the 5.5% debt cost. CAB says it will not permit this dilution to reduce an airline's rate of return below 9%.

This new CAB policy is designed to force local airlines to reduce their debt ratios and substantially increase the equity portion of their investment bases. The Board also said it wanted to avoid "windfall" returns on equity which could occur with high debt ratio carriers if an industry-wide uniform debt ratio were used.

It was to avoid such windfalls that CAB turned to the sliding scale formula applied individually to each airline. Arriving at the appropriate debt ratio posed a real dilemma, CAB said, since adopting the examiner's recommendation for a uniform debt ratio would have meant heavy windfalls to many carriers, while using the industry's actual average debt ratio of over 70% might "freeze" the airlines' financial structures into "an undesirable mold."

The Board felt that use of the actual debt ratio in the final formula might hinder an airline's efforts to reduce its debt since any substantial reduction in the debt ratio would be reflected by a sharp dilution in the rate of return on equity.

On this basis, the Board said a flexible formula was adopted to provide a rate of return on investment ranging from a low of 9% to a maximum of 12.75%, depending upon the individual carrier's actual debt ratio. At the same time, the Board voted to retain the present 7% rate of return being permitted for past periods, on grounds that it is above that realized by public utility companies.

Pointing to local service difficulties in raising equity capital, the Board said that while the new rate will result in somewhat higher subsidy payments, application of the order should encourage the airlines to expand their equity base to improve service and efficiency, "which, over the long run, should reduce the subsidy need."

The rate increase will apply to future final rates and will be adjusted whenever new mail rates are established to reflect the carrier's actual financial structure, the Board said.

CAB Member G. Joseph Minetti concurred in granting the increased rate of return on investment but objected to the return of 21.35% on equity as too high. A 16.44% return on equity would have been "ample for enterprises which can look to the U. S. government to make up the difference between revenues and expenses, including capital costs."

Minetti also disagreed with Board philosophy that the new rate will lead to less subsidy need for the carriers and noted that such a self-sufficient status could be realized only by increased traffic volume needed to cover break-even requirements. "Permitting this highly protected industry a rate of return appropriate for a highly speculative industry," he said, "will obviously increase its need and to that extent retard its progress towards self sufficiency."

Release of the Board's order also is causing some confusion in financial circles, which optimistically began advising prospective investors to buy local service airline stocks and bonds on the strength of CAB's earlier press announcement. This optimism was further heightened, one investment analyst said, when CAB Member Alan S. Boyd publically announced the local service airlines could expect a new "class mail rate" plan by January, 1961. A rate of return using the formula announced in the CAB press release last June, coupled with the class mail rate, made financial ventures into local service stocks a promising investment, he said.

A question which is causing added confusion among the airlines and investment houses is whether or not convertible subordinated debentures issued by several carriers to finance new equipment, will be considered debt or equity by the CAB.

Sources of Financing

In some cases, such as Allegheny and Mohawk Airlines, carriers contend they have followed the Board's stipulations that all sources of financing be exhausted before applying for Guaranteed Loans for new equipment. To do this both carriers issued convertible subordinated debentures, thus eliminating a need for guaranteed loan aid.

Allegheny has issued $5.5 million in debentures and Mohawk $3.5 million. CAB figures list debt ratios as 70.76% for Allegheny and 88.18% for Mohawk. Should the Board decide that debentures must be considered debt for rate-making purposes instead of equity as claimed by the airlines, Allegheny and Mohawk, both of which have undertaken heavy equipment expansion programs, could possibly realize a rate of return considerably lower than their presently allowed 9.5%.

Allegheny supports the principle that debentures, which could eventually be converted into stock and which have about the same flotation costs, should be recognized as equity by the Board in the same manner that common stock issues are.

TWA Delays Merger

Trans World Airlines directors deferred consideration of the proposed merger with Northeast Airlines at a board meeting last week, and Northeast's board agreed to a time extension until Sept. 30 for further consideration.

Action on the TWA financing is pending. Members of the lending group are reported to be seeking stronger control of TWA in the wake of the resignation of the airline's president, Charles S. Thomas—either through the placing in trust of the controlling stock interest of Howard Hughes during the life of the loans or in appointment of a board member representing the insurance company participants.

Joint Route Decision Requested by Western

Washington—Western Air Lines asked the Civil Aeronautics Board last week to consider the Trans-Pacific Route Case, Southern Transcontinental Service Case and Pacific Southwest Local Service Case together and decide them all at once.

The airline warned that the Board must decide whether it wants regional trunklines to continue to operate in the jet age or permit the entire trunkline industry to be "converted into an oligopoly of five or six gigantic trunklines." The move for consolidation represents a growing belief within industry circles that route adjustments can no longer be considered on a sectional basis in view of the wide operating range of turbojet equipment, but must be handled on an over-all basis.

Western said in its petition that the Board's decision in the three cases "could create a situation which would cast a serious doubt on Western's ability to survive the jet age." It added that unfavorable recommendations by the Board's staff in each of the cases placed the airline in a "gigantic squeeze" that could deny it access to long-haul jet services while subjecting it to revenue diversions through multiple competition.

Briefs in the Southern Transcontinental Case were filed last week, and oral arguments are scheduled to begin Sept. 26. Oral arguments in the Trans-Pacific Route Case will begin Sept. 7. Examiners decision in the Pacific Southwest Case is expected late this month. Western said it was not asking that oral arguments in the three cases be held simultaneously.

The airline stated that it was not "so myopic or self-centered" to request that its problems be considered to the exclusion of other carrier.

Route Awards to Local Airlines Draw Strong Dissent From Gurney

Washington—Lake Central and North Central Airlines won extensive new routes last week in a Civil Aeronautics Board decision which drew a strong dissent from Vice Chairman Chan Gurney.

Gurney's criticism concentrated entirely upon the votes of Chairman Whitney Gillilland and member G. Joseph Minetti in granting new routes to Lake Central, which the vice chairman contends takes the airline "out of the local service category and in fact makes it a regional carrier through the heaviest populated part of the United States" through a series of routes extending from Chicago, Ill., to Washington, D. C.

Gurney also speculated that the new mileage awarded to Lake Central in the Great Lakes Local Service Investigation will require significant subsidy increases for the carrier, which he pointed out will be competing directly with several trunklines in the new territory plus entering the existing market areas of Allegheny Airlines and Piedmont Airlines.

Awards to both Lake Central and North Central were made subject to CAB's "use it or lose it" policy. Board authorized the new services either indefinitely or for five-year periods as a means of reducing the number of renewal cases normally resulting from the normal three-year authorizations.

In line with this new policy, CAB said "indefinite" awards were made on the basis of pressing public need for the route, even at a high subsidy cost, or where the necessary subsidy requirements would be so far below that of the average local service route as to encourage extension of a temporary authorization, even though its revenues might prove lower than the airline projected. Five-year awards were made to give the carriers a better opportunity to develop traffic potentials on the new routes.

With this yardstick, the Board gave Lake Central these new routes:

• **Detroit, Mich., to Pittsburgh, Pa.,** via Toledo, Sandusky, Cleveland, Akron/Canton and Youngstown, Ohio; Erie, Pa., to Pittsburgh; and Charleston, W. Va., to Pittsburgh, via Elkins, Clarksburg/Fairmont, Morgantown, and Wheeling, W. Va., all for an indefinite period.

• **Columbus, Ohio to Washington, D. C.** and Baltimore, Md., via Zanesville, Ohio, and Wheeling and Morgantown, W. Va.; Cincinnati, Ohio to Washington and Baltimore, via Portsmouth, Ohio, Parkersburg, W. Va., Marietta, Ohio, and Clarksburg/Fairmont and Elkins, W. Va.; and Grand Rapids, Mich., to Columbus, Ohio, via Jackson, Mich., and Toledo and Mansfield, Ohio, for a five-year period.

• **Columbus to Akron/Canton, Ohio** service also was approved for a five-year period, along with other new route segments including Terre Haute, Ind., to Cincinnati via Bloomington and Columbus, Ind.

North Central's route system was expanded to include these new routes:

• **Detroit to Cleveland** and Sault Sainte Marie, Mich., to the alternate terminals of Chicago, Ill., and Detroit, Mich., via Pellston, Traverse City, Manistee/Ludington, Cadillac/Reed City, Grand Rapids, Benton Harbor/St. Joseph, Alpena, Saginaw/Bay City/Midland, Port Huron, Flint and Pontiac, Mich., all for an indefinite term.

• **Escanaba, Mich.** to Saginaw/Bay City/Midland, Mich., via Traverse City, for a five-year period.

• **Muskegon, Mich.,** to Milwaukee, Wis., and Milwaukee to Chicago. Both with permanent authority.

Existing restrictions on Allegheny Airlines' routes were lifted to allow nonstop flights between Pittsburgh, Washington and Buffalo and between Pittsburgh and Huntington, W. Va.

The West Virginia cities of Clarksburg, Morgantown, Wheeling, Elkins and Parkersburg were deleted from the route systems of American, Capital and Trans World Airlines. Cheboygan, Sault Sainte Marie and Traverse City, Mich., and Erie, Pa., also were deleted from the Capital system by the Board.

Beyond his immediate objections to the geographic scope of the Board's awards to Lake Central, Gurney said he would have certificated Piedmont to serve the West Virginia cities and also would have limited the route authorizations to three years. Already established in West Virginia and with Washington as an eastern terminal, Piedmont would require less subsidy to operate the new routes, he said, on the basis of system results of a break even need to commercial revenue ratio of 0.37 for Piedmont, compared with 0.63 for Lake General.

Extension of the Lake Central system 400 mi. into Washington was considered "completely unjustified" by Gurney, who contended that the airline should be given time to "digest" other new routes recently awarded it "without being saddled with more than it can develop with its limited resources."

The vice chairman also objected to the five-year authorizations granted by CAB, pointing out that the difference between a three-year and five-year award is the amount of subsidy needed if the route fails to meet the standards for renewal.

FIRST PICTURE of a modern Russian aircraft in production shows the Ilyushin Il-18 undergoing installation of its Ivchenko AI-20 turboprop is used by Czechoslovak Airlines, MALEV, the Hungarian airline, and by the Red Chinese airline, and has been ordered by the new Ghana

Il-18 Grounded During Crash Probe

Moscow—Soviet Union has grounded the Il-18 turboprop transport for investigation following a crash which killed 27 passengers and crew members last month near Kiev (AW Aug 29, p. 45).

Although no reason has been given for the grounding, excessive vibration, first reported by AVIATION WEEK (AW Aug. 3, 1959, p. 40), has attracted much attention from western airline operators who have flown in the aircraft. One western observer reported a "pulsing vibration running through the fuselage every two and one-half seconds" during a recent flight between Baku and Moscow. Aeroflot officials have told western airline personnel that the vibration problem is being corrected.

Meanwhile, the Soviets have made every effort to substitute other aircraft for the Il-18 fleet, particularly on international routes, although several Il-18 flights were necessarily canceled due to the grounding.

Two Il-14 transports were put in service on the Moscow-Stockholm route as replacements for an Il-18 schedule. Early last week, Intourist told booked passengers that flights to Vienna from Moscow would be completed, but not with Il-18 equipment.

Other cities served by the Il-18 include Helsinki, Cairo and East Berlin. The Tu-104 turbojet transport operating on Aeroflot medium-range routes does not have the long-range capability necessary to serve such routes as Moscow-Cairo nonstop, a service the Il-18 has been operating.

Grounding of Aeroflot's Il-18 transports will have a serious impact on the Soviet carrier's domestic and international operations.

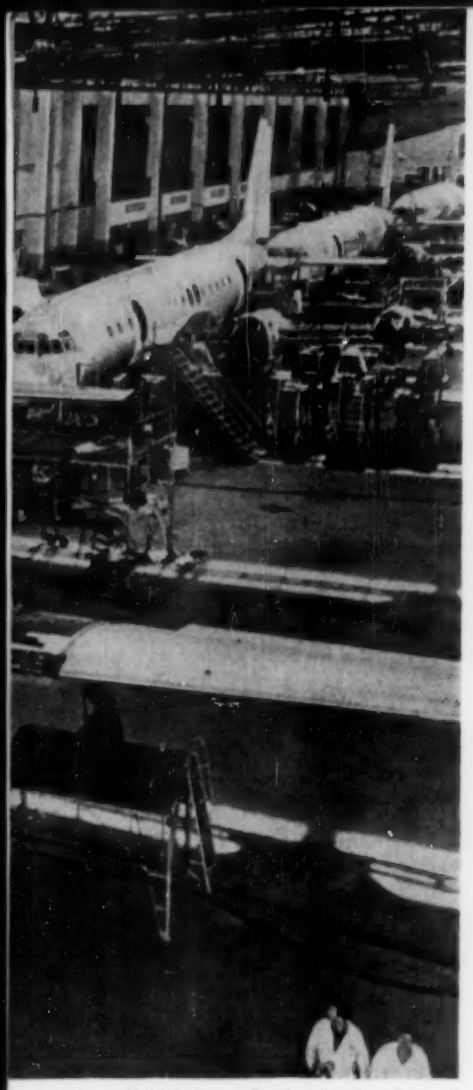
Now in mass production, Il-18s have provided more new seat capacity for Aeroflot during the past year than any other type of transport used by the airline.

By early summer, after being in regular service only six months, Il-18s were being operated on 31 Aeroflot routes. By contrast, twin-jet Tu-104s, which have been in scheduled service for four years, are flown on 39 routes, and the four-turboprop An-10 on 15 routes.

Any admission of a serious defect in the Il-18 would be an especially heavy blow to Soviet prestige since the craft's designers have received one of the USSR's top honors—the Lenin Prize for 1960.

Eurocontrol Accord Expected in November

Paris—Ratification of a final working agreement between member nations of Eurocontrol, a new organization scheduled to standardize air traffic control



engines. Il-18 is in production for Aeroflot and national airline (AW Aug. 29, p. 45).

procedures over much of Europe, is expected at a Brussels meeting in mid-November.

Prior to the Brussels meeting, a preliminary diplomatic conference of the ministries concerned probably will take place in Paris sometime this month. On June 9, Eurocontrol members representing the six common market countries and the United Kingdom reached general agreement on future procedures at a meeting in Rome.

On a provisional basis, two major control zones will be established—in Paris for central Europe and in Rome for southern Europe. These are expected to begin to function by early 1963 but, according to Eurocontrol's present plans, it will require about five years after final agreement is signed for the system to become fully operative.

For the transition period of about one year, headquarters of the organization will remain in Paris. Later, it will be transferred to Brussels on a permanent basis.

A. V. Roe to Begin Detailed Study Of Twin-Fan Short-Haul Avro 771

London—A. V. Roe, Ltd., will begin a detailed design study of the Avro 771 twin-turbofan, short range transport, following a favorable assessment of a worldwide market survey (AW Mar. 14, p. 47).

The aircraft will be powered by two Bristol-Siddeley BS.75 turbofan engines believed to have a fan ratio as high as 1.8 to 1. An alternative version powered by two Rolls-Royce RB.165 turbofan engines of considerably lower fan ratio has been dropped.

The Avro decision to proceed with the transport means that Britain's two newly formed airframe groups now may meet head-on in a new field—that of the short-range jet.

Contestant from the British Aircraft Corp. is the ex-Hunting P.107 project, dating to 1957, which has been spruced up by BAC and widely canvassed to airlines. A decision on the P.107 by Vickers is expected this month (AW Aug. 1, p. 40). Both aircraft mount the same engines in the same place at the rear of the fuselage.

The timing of the Avro announcement could be significant in view of the military requirement for a short range jet replacement for the Vickers Varsity communications and crew training aircraft. The government has made it clear to the two companies that it will replace this aircraft only with one that is commercially available, and will not issue a special specification. Any support from the government therefore is not expected until one of the companies has clearly indicated its intention of large scale civil production.

New details released by Avro show that the Avro 771 will gross 52,000 lb. Cruise performance data (ISA conditions) includes a design cruise speed of 570 mph. (Mach 0.82) at 25,000 ft.

Payload of the Avro 771 is 12,000 lb. Its capacity fuel load of 16,000 lb. gives the aircraft a full load range of 500 naut. mi. and a maximum range of 1,700 naut. mi.

A choice of interior layouts is available, ranging from a 42-seat, 36-in. pitch arrangement to a 60-seat economy class configuration with seats at 32 in. pitch.

The basic aircraft offered to operators will include air conditioning, pressurization and refrigeration systems, airframe and engine anti-icing, Smith's flight and control systems, pressure refueling, water injection, thrust reversers and comprehensive radio and navigational equipment. The engine weight for a fan ratio of 1.7 is listed at 1,500 lb., giving the engine a thrust to weight ratio of 5:1.

Fuel consumption at cruise altitude is shown to vary over a wide load range from 0.76 to 0.82 lb. per lb. thrust per hour at maximum cruise. Holding at Mach 0.35 at 5,000 ft., the specific fuel consumption drops to 0.63 lb. per pound thrust per hour.

The BS.75 is the outcome of the engine maker's market survey which showed the need for a major aircraft replacement in two size categories, one grossing between 40,000 and 50,000 lb. and the other between 70,000 and 90,000 lb. Based on takeoff wing loading, approach speed and landing-to-takeoff weight ratios, the Bristol calculations showed that the optimum ducted fan engine size to suit both categories was in the 6,000 to 8,000 lb. region, the smaller aircraft being powered by two units and the larger aircraft by four.

The BS.75 is believed to have a fan flow of 200 lb. per second and a high pressure flow of 45 lb. per second.

Avro 771 has a wing span of 77.5 ft., a length of 80 ft. and it stands 24 ft. high. Wing area is 800 sq. ft., aspect ratio 7.5 and sweepback is 30 deg. Thickness chord ratio varies from 11 to 9%. The wing has 70% leading edge slats with the flaps spanning 64% and with 30% wing chord.

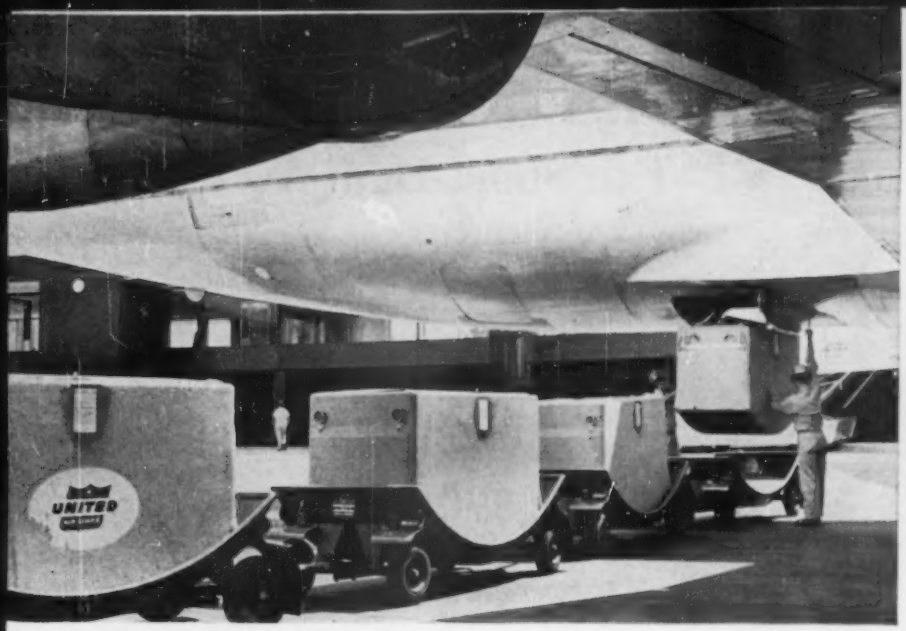
Contingency Rating For Helicopter Turbines

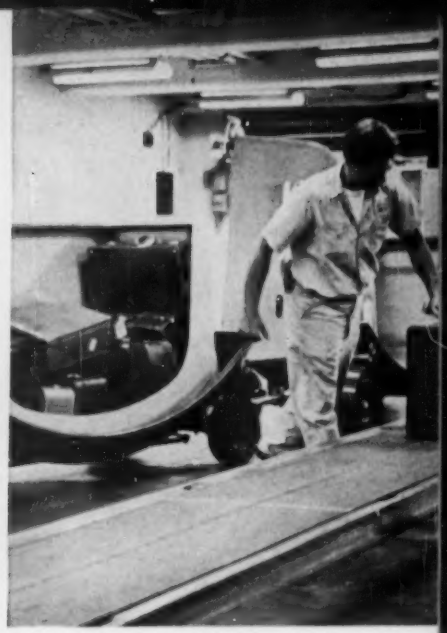
Washington—Chances appeared strong late last week that industry and the Federal Aviation Agency will reach full agreement on a contingency rating for commercial helicopter turbine engines.

General Electric Co. has made a proposal for its T58 turbine engine, and Aerospace Industries Assn. has sent a letter to FAA supporting the proposal which is expected to produce an agreement. In the past, FAA has balked against setting a contingency rating because, it charged, manufacturers were unable to reach any agreement among themselves.

Certification of the T58 now calls for takeoff power of 1,250 eshp. for a maximum of 2½ min. and civil maximum horsepower rating of 1,050. GE wants to increase maximum horsepower rating limits to one half hour, thus permitting a multi-engine helicopter with an engine out en route to continue the flight to a safe landing.

With this contingency rating, an all-weather civil operation at maximum gross weight would be permitted. With the 2½ min. limit, gross weight must be reduced for all-weather operations.





UNITED baggage containers are unloaded from arriving DC-8 by self-contained aircraft system (left), carted to central baggage room (center).

New Concept in Terminals: Part II

Machinery Speeds Baggage at Idlewild

By Glenn Garrison

New York – Plane-level passenger boarding, mechanization of baggage handling and some elimination of ramp service vehicles are key innovations of Idlewild's decentralized passenger terminal (AW Aug. 22, p. 36).

Four airlines are now operating from their own buildings in the $150 million complex, with three additional terminals scheduled to complete the facility. American, Eastern, Pan American and United now have their own terminals, all financed by the Port of New York Authority under long-term lease, with airlines letting their own contracts for design and construction. All have incorporated one or more of the new features to some degree at their individual sites.

In addition to the existing International Arrivals Building and its foreign-flag wing buildings, a Trans World Airlines terminal, a Northwest terminal, and a common terminal for remaining carriers will complete the basic plan of Idlewild's passenger area.

Proposed airline mergers may make their mark on the final setup, for example:

• **TWA's new terminal,** now under construction and expected to open next year, will have to provide space for the Northeast Airlines operation if it becomes part of TWA through a merger

AMERICAN Airlines containers are removed from Boeing 707-120 by external hoist (left) and towed to the baggage claim area in the new

Bags are moved by conveyor belt to the claim counter, where they are distributed by automatic moving car (right).

now being studied (AW May 23, p. 38).

• **Northwest may seek** another participant in its terminal to replace Northeast if the merger goes through. Under previous plans, Northeast and Braniff were to share in the Northwest facility.

• **United's terminal** will have to provide for the Capital Airlines operations if United absorbs Capital in a merger now being discussed. United Air Lines now has a subtenant, Delta Airlines, in its terminal.

• **Consolidated terminal,** planned for Port Authority construction, will have one less prospective tenant if the merger takes place. Capital now has space in the old temporary terminal which will be replaced by the consolidated "union terminal."

In the existing terminals, some carriers have equipped their aircraft gates with built-in facilities such as external power, cutting down the clutter of ramp service vehicles. The four airline terminals also are equipped for underground hydrant fueling, if fuel delivered by this method to the terminals becomes available. The International Arrivals Building ramp can be adapted to underground fueling by removal of a strip of blacktop, as opposed to full-stress concrete ramp, which rings the fingers of the building.

If and when negotiations between the Port Authority and the airlines are completed for the underground system, it will probably consist of a satellite fuel storage point from which the terminals will be supplied. To supply the satellite area, underground pipelines probably will run about 8,000 ft. from the present tank farm, where fuel is brought to the airport by barge, to the satellite storage area. Cost of the project is expected to be reduced by the satellite arrangement. Fuel can be pumped at low speed to the satellite area, then at the needed high speed and more expensive rate into the actual aircraft fueling lines.

Airline operations at the existing terminals vary in some degree according to the needs and preferences of each. Here is the breakdown, in order of the

terminal (right). Bags are unloaded from containers and placed on the self-claim counter at ground floor level.

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official opening of the air terminals:

Eastern Air Lines opened its $22 million terminal last October. It averages about 6,000 passengers a day through the building, with perhaps 4,000 visitors. Biggest of the unit terminals, it contains 361,280 sq. ft. of floor space. Boarding and deplaning presently are strictly conventional: by passenger stair out in the open. Covered bridges could be added later if Eastern decides to go in for them, but no decision has been made. Eastern is waiting to see how the other airlines' systems work out.

The terminal is a split-level operation, with second-floor, under-roof lanes for arriving ground traffic. Baggage mechanization consists of conveyor belts from driveway and ticket counters to the lower-level baggage room, respectively, for the baggage of departing passengers who have and have not prechecked their baggage. From the baggage room to the plane, and from the plane back to the claim counter, the flow of baggage is strictly the old bag-on-a-cart system, without containerization.

There are 16 aircraft gates divided equally between two 350-ft.-long second-floor fingers, each finger containing one waiting room. Deplaning passengers go up a ramp to the second floor and down another to ground floor level for baggage claim and outgoing transportation.

Jet Start

Eastern's jet ground support facilities are not as yet built-in. Jet start is accomplished by turbine truck. No towing in or out is necessary.

Flight information is well displayed in the Eastern terminal by means of 28 ft. x 6½ ft. lighted boards, seven of which are located in the main lobby and elsewhere. Information is posted electronically by a coordinator in a tower above the terminal. The coordinator also controls ramp activity and makes flight announcements.

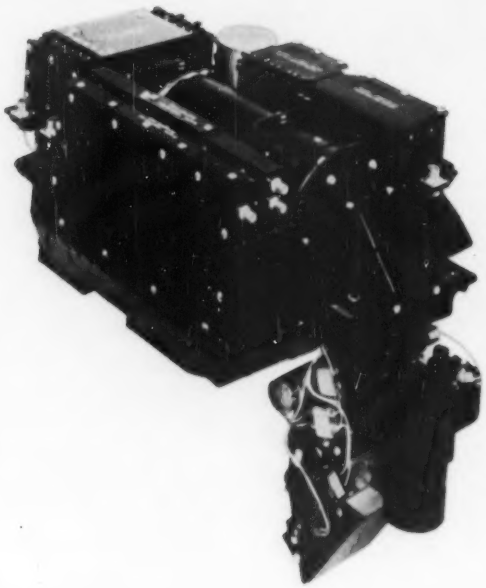
These big information boards were burning up bulbs at the rate of several hundred a week during early operation, requiring the services of two men four hours a day to make replacements. Reduction of power, however, has almost eliminated this bug.

Part of Eastern's terminal is occupied by a subtenant, local service carrier Mohawk Airlines. In addition to a handsome "Falcon Room" restaurant overlooking the field side, the building houses a number of concessions.

United Air Lines' new $14½ million facility, officially opened last May after limited use since last September, contains some of the most elaborate equipment in the airport terminals. Boarding and baggage handling systems are highly mechanized, with two enclosed passenger "Jetways" rolling out to serve each jet flight. These fully-enclosed passage-

CHECK-IN area is near passenger entrance of new Pan American terminal (above). Bags are conveyed by belt from counters to lower level, loaded into portable bins.

LOBBY of American Airlines terminal (above) is at second-story level. Ticket counters extend along glass wall separating lobby from ramp. Below, express baggage check-in counter in United Air Lines terminal features automatic computing of excess baggage charges, bins of tags for self-tagging by passengers.



TV SYSTEMS SKY-HIGH

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ways, controlled by an operator at a panel in the cab, telescope out from the terminal, swing left and right, tilt up and down.

United has installed nine Jetways at Idlewild, providing six jet gates and a piston gate (one Jetway is used with Douglas DC-7 flights). Plans call for adding four more of the devices for a seven-jet-gate total. The airline also has installed Jetways at San Francisco (AW Aug. 15, p. 47), and expects them to go in at Los Angeles and Seattle.

The airline told AVIATION WEEK that "upward of $900,000" will be spent in buying and installing the devices at Idlewild. They are made to United's functional requirements and specifications by the PI Steel Corp. of Los Angeles.

There have been some problems in breaking in the Jetway operation, including one case where an aircraft was damaged while positioning the Jetway. The aircraft had to be pulled out of service for repairs.

A network of baggage conveyor belts, the longest 350 ft., serves a central baggage room in United's terminal at Idlewild.

The longest belt tunnels are under the sidewalk where limousines are unloaded, and makes its subterranean way to the central room, where it comes up again, bringing bags to be loaded into containers and towed out to the ramp.

Other incoming lines feed away from check-in positions and merge into one belt which travels alongside the "limousine belt" to the baggage room. Baggage of incoming passengers goes by cart from plane to baggage room and onto another belt which takes it to the claim counter.

As the first bag off an incoming flight emerges into the claim area, it passes an electric eye, starting in motion a car which travels slowly up and down the length of the counter. The incoming baggage belt feeds bags to the car, which has its own belt system. Bags climb up on the car, turn 90 deg., and spill onto the self-claim counter. If the system is working perfectly, bags are automatically spaced along the counter as the car moves back and forth.

This complicated baggage system, certainly the boldest innovation of its kind at Idlewild, cost United more than $160,000, according to the airline. Similar systems are in operation at Los Angeles and San Francisco.

There have been unavoidable bugs in connection with the system. Baggage has been chewed by conveyor belt rollers, and frequent checking is necessary within the bowels of the system to locate bags which often fall off on turns.

The baggage containers used with United's DC-8s are raised and lowered by a system within the aircraft itself, requiring no external hoist.

Passenger entrance and exit from the street side of United's terminal are both at ground floor level. Incoming passengers check in downstairs, then escalate to the second level, where lounges, concessions, observation deck and gates are located. Jet passengers are segregated by class in separate boarding lounges in the finger, and enter their aircraft through separate Jetways to each door.

An unusual feature of United's check-in facilities is the "express baggage check-in" counter used at peak periods. Baggage scale is linked to a computer which figures any excess weight charge. The passenger is given his charge slip immediately, and the bag proceeds into the conveyor belt system to the baggage room. The charge is paid a few feet away at another agent location. This installation also includes tags for the passenger to tag his own baggage if he desires.

United says the average time through this express check-in is 1 min.

Flight information presently is provided by closed-circuit television units scattered throughout the terminal, but United plans to supplement these with a big lighted board in the ground floor space.

United starts its DC-8s with turbine trucks and aircraft are taxied in and out. All servicing is with external ramp vehicles.

Delta Air Lines has moved all its flights to the United terminal, where Delta is now a subtenant, which uses one of the two fingers. This finger is still under construction and Delta uses passenger stairs and a roped-in open-air walkway along the edge of the ramp to the terminal. When the finger is completed in a couple of months, Delta will have four gates; now it has two. Plans include installation of passageways similar to American's, with single-door loading from lounges in the finger. Delta taxis its DC-8s and Convair 880s into the terminal and pushes them out by

BAGGAGE is unloaded by hand from Eastern DC-8 at Idlewild (above), carted to self-claim counter on ground level of new Eastern terminal building (below).

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tug. Starting is with turbine trucks.

American Airlines now handles about 3,000 passengers a day in its $14 million facility which opened for business last February. A major feature is the covered telescoping passenger walkways which connect departure lounges with jet doors. There are four departure lounges and gates in each of the building's two fingers, plus two gates without lounges in each finger. Each finger could be extended to include an additional two or three lounges and gates. Jets are nosed up close to the terminal under their own power, pushed out backward by tugs for departure.

First-class and coach passengers are not segregated in the lounges, but are boarded separately through the forward door of the jets. Rear doors are not used.

Propeller flights are boarded by conventional passenger stairs from the gates without lounges.

Jets are started at the gates by means of aircraft-carried start bottles or turbine-starter trucks. The jet gates provide built-in external power cables, eliminating ramp vehicles for this purpose.

Baggage is carried on the Boeing 707-120 jets in containers loaded and unloaded from the plane by external hoists. The containers, one to a cart, are towed in train from the aircraft to the ground-level claim area, where bags are unloaded and set on the self-claim counter.

Flow of departing passengers from taxis, cars and coaches moves into the terminal at second floor level to ticket counters along the glass-walled ramp side of the lobby. Flight information is posted on a single board behind an information counter in the lobby. Passengers move right or left from the lobby to their gates in the fingers at either end.

Arriving passengers descend from the lobby via escalator to the ground floor, claim baggage and exit to ground transportation on that level.

Concessions in American's terminal are confined to eating and drinking facilities and a newsstand-shop in the lobby. The restaurant, a Sky Chef facility, looks out on a relatively unattractive vista: a closeup of the ramp side of a gate.

One of the problems American has solved in its terminal operation was failure of an I-beam on its jet bridges, causing the end of the bridge to fall into a sagging position. No passengers were aboard during any of the incidents of this nature. All bridges have been reworked to correct this problem.

Another shakedown incident in American's operation occurred when the tail of a jet broke a lobby window and poked through into the ticket counter area. This was caused by faulty procedure in backing the plane out with a tug.

American will soon have a promotionally desirable subtenant in New York Airways, scheduled to move its Idlewild operation to an American gate in the near future. The helicopter carrier now uses the temporary terminal.

Pan American's almost circular terminal with overhanging concrete roof is considered by many observers the most original design on the airport from a functional standpoint, and certainly a top contender for esthetic honors. Smallest of the terminals, it was put into operation May 24.

Jet aircraft are brought under the roof to their loading gates, separated from passengers inside the terminal by the glass walls. One effect of this arrangement is an immediate feeling of intimacy between the passenger and his flight. Pan American dramatizes this with lighting effects during night departures. When a flight is called, the procedure is to fade the lights at the gate position from white to red, and throw spotlights from the roof onto the aircraft and boarding bridge.

PanAm boards its jet passengers via an unenclosed "airbridge" device, using the forward aircraft door only. The bridge is powered for movement laterally and the loading platform at its outer end can be raised and lowered. Piston departures are handled with passenger stairs, with passengers descending to ramp level.

Gate Positions

Jets are brought in under the roof under power, towed out and started beyond the covered area. Gate positions are equipped with built-in external power, and facilities for built-in air conditioning service have been installed but are not in use.

An important limitation of Pan American's terminal design is the relatively few gates that it provides. There are now six positions under the roof, and that is the maximum. Two additional gates are located at the back end of the terminal—that is, the field side—but these are not under the roof. Only expansion possible is in this direction, and perhaps two additional unprotected gates could be installed. Such gates would be extraneous to the basic circular design of the terminal.

The Pan American building, therefore, would be unsuitable for an airline with high-frequency operation requiring more gate positions. Pan American's requirements are different. All arriving flights except those from Nassau and Puerto Rico are handled at the International Arrivals Building, where Customs, Health and Immigration facilities are located, thus taking a big part of the load off the PanAm terminal.

Generally, Pan American's jets are taken to the hangar for servicing after arrival, but for fast turnaround, servicing is sometimes done at the International Arrivals Building gate or out on a hardstand near the terminal.

PanAm's shakedown problems with its loading bridge included some chewing up of the ramp by movement of the bridge through its lateral arc. This was rectified with metal tracks.

Baggage of departing passengers in the PanAm terminal goes into a belt system which takes it to a lower-level baggage room, where it is sorted by flight and loaded onto metal bins. The bins are forklifted to the aircraft and the baggage is loaded by hand. Arriving baggage is put in the bins and moved by fork-lift to the ground-level claim area, where the bins are set on a conveyor and propelled along the claim counter. Passengers take their bags from the bins and the empty bins are mechanically raised to the ramp for collection.

Deplaned passengers reach the street at ground level in the PanAm terminal, which is a split-level operation with arriving ground traffic at the second level. The overhanging roof covers both levels of street traffic.

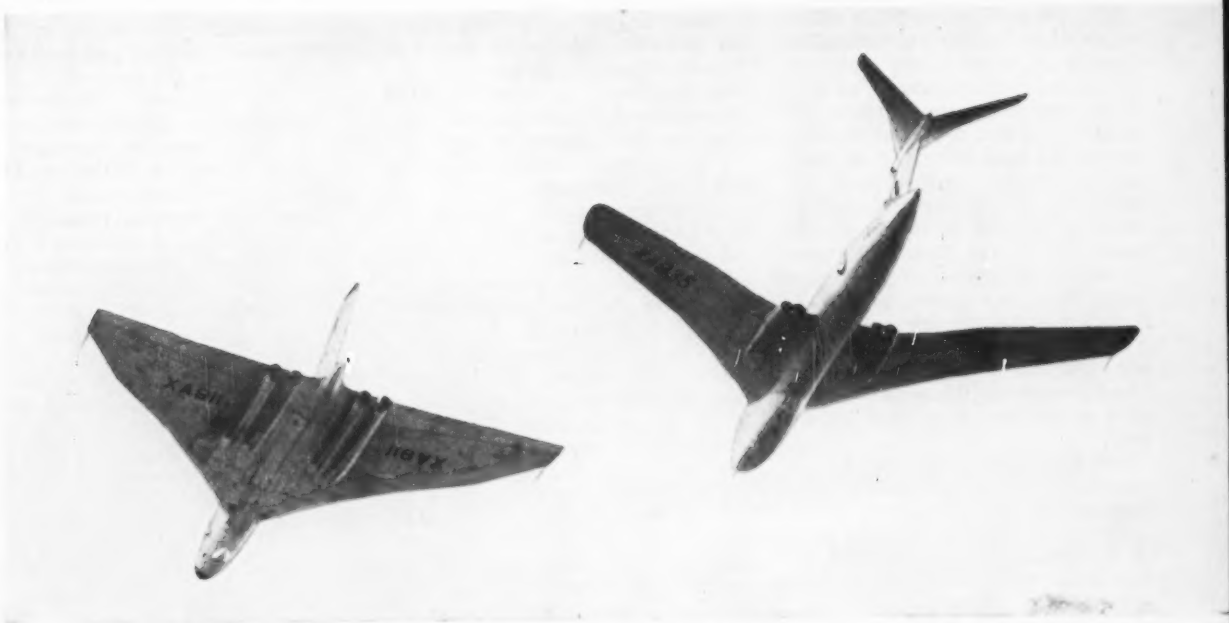
Pan American has experienced some problems and banged bags with its baggage belt system, too, and has made modifications. A basic problem to be solved in these systems is the variety of bags the belt must accommodate.

Flight information in PanAm's terminal is provided by a lighted board in the lobby. A similar board is located in the dispatch office, and plans are to link the reservations office in Long Island City and the East Side Airlines Terminal in Manhattan with additional units.

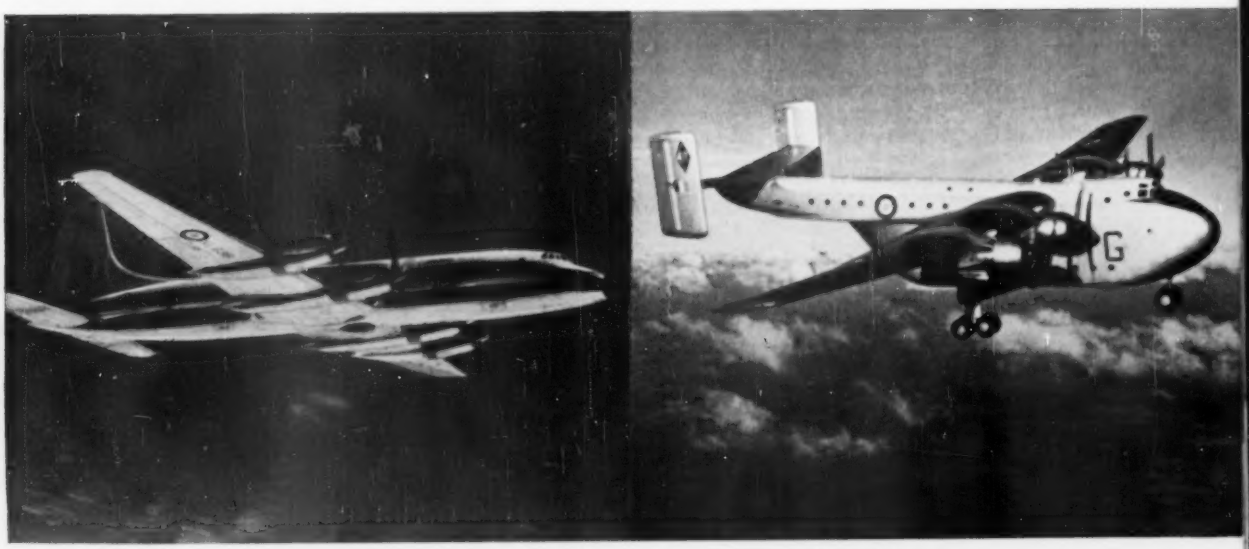
Pan American averages about 1,500 departing and 500 arriving passengers a day through its new terminal.

Trans World's new building, subject of considerable comment in the design stage because of its striking "bird in flight" shape, will include two "islands" or "ramp houses" at the ends of short fingers extending from the central building. Each island will accommodate seven aircraft ranged around its seven sides, and passengers will board by telescoping covered walkways leading from the island's lounges.

Until this building opens next year, TWA is handling passengers at a new $300,000 facility it has built to serve temporarily. Opened last month, this interim terminal is used exclusively by TWA but adjoins the common-use temporary terminal still used by Braniff, Capital, Northeast, Northwest, Trans-Canada, and Trans Caribbean. New York Airways helicopter services also operate from this area, although they shortly will be moved to American's terminal.



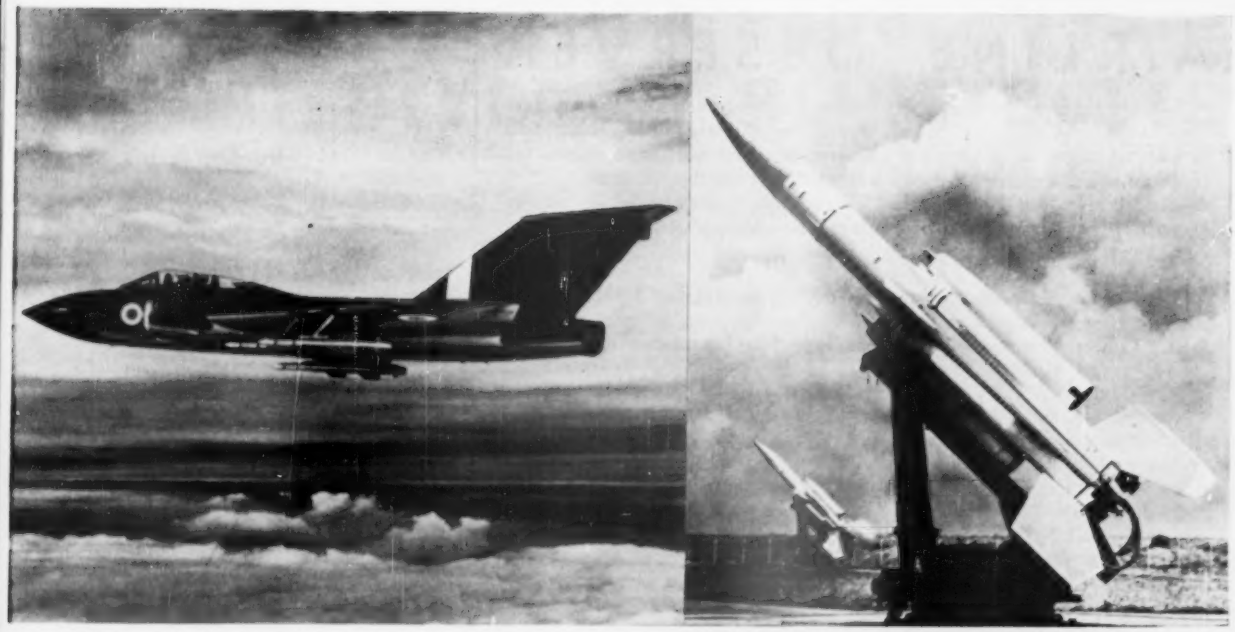
RAF V-bombers fly 10 miles a minute, 10 miles up, for 10 hours . . .



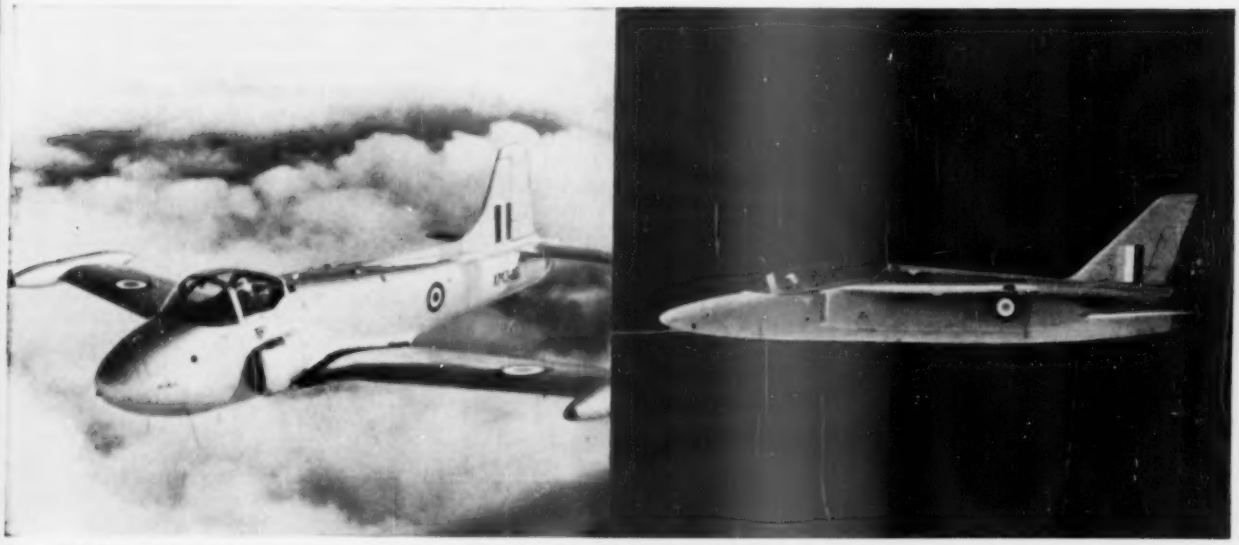
RAF Transport Command provides 5,000-mile range—20-ton payload capacity . . .

. . . AND BRISTOL SIDDELEY

Bristol Siddeley Engines Limited, one of the largest manufacturers of aero-engines in the world, supply flight power for a large proportion of the aircraft and missiles of the Royal Air Force. The most potent part of the RAF's strategic V-bomber fleet, the bulk of its round-the-clock defence, the majority of its transport aircraft and all its new primary and advanced jet trainers are powered by Bristol Siddeley.



RAF round-the-clock defence intercepts aircraft hundreds of miles out, far up into the stratosphere . . .



RAF Training Command orders the latest primary and advanced jet trainers . . .

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AIRLINE OBSERVER

▶ Triple-turbine engine layout for helicopters continues to interest scheduled commercial operators, but economics are still prohibitive. New York Airways visualizes a one-to-eight climbout gradient with one engine out in a triple-turbine layout as against a one-to-twenty gradient in a twin-engine configuration. Vertol has studied four-turbine configurations as well as three, but found the economic problems still remained—extra initial engine cost, accessory duplication and payload reduction.

▶ Draft version of Federal Aviation Agency's state-of-the-art report on steep gradient aircraft has gone out to industry for comment. Report is part of FAA's Project Hummingbird, a technological and economic study of the civil future of V/STOL aircraft.

▶ Northwest Airlines is citing concern over the Lockheed Electra modification program as a major reason for not taking delivery on eight more of the turboprop aircraft. President Donald Nyrop reports that he considers Lockheed Aircraft Corp.'s current modification program "optimistic" and that the manufacturer has so far failed to meet Northwest contract specifications for speed and other performance factors. A decision on accepting the eight aircraft remaining of the 17 Electras ordered will be made in the near future, he said.

▶ International Brotherhood of Teamsters is relying on internal friction among airline labor groups to gain an eventual foothold in the industry. Small groups of ground personnel of Pan American and Trans World Airlines already belong to the Teamsters, and the union now has petitioned the National Mediation Board to hold an election to represent all of the ground personnel at National Airlines. In addition, Eastern Air Line pilots at Miami recently discussed, but tabled, a motion to encourage the Air Line Pilots Assn., to form an alliance with the Teamsters.

▶ Number of flights serving the North Atlantic dropped 6.7% during the second quarter of 1960 compared with the same period last year, but because of larger turbojet aircraft and increased emphasis of economy class, traffic for the period showed a 26.8% increase. Economy class accounted for 80.9% of the total passengers carried. Load factor on eastbound flights for all scheduled carriers totaled 90.4% in June, while westbound flights flew at little more than 50% capacity. Load factors for all flights during the second quarter reached 70.9%, an increase of 3.4 points over the same period last year.

▶ Watch for a Hughes Aircraft Co. proposal to Lockheed Aircraft Corp. that the two companies jointly finance the development of an automatic simulator for installation in a Lockheed JetStar to simulate the dynamic response of a heavy jet transport for pilots. Federal Aviation Agency turned down Hughes' request for support on grounds that funds are not available and that the original proposal did not cover crew training. Hughes plan now calls for modifying the cockpit for procedure as well as flight training. Airline interest in the simulator pending FAA certification indicates to Hughes that a market exists for 30 such systems.

▶ New microwave beacon guidance system for final approach and flare-out use will be tested later this year by British as an alternative to the buried leader cables now used to give precision azimuth guidance before touchdown. Microwave beacon, being developed by Elliott Brothers, Ltd., of London, will operate in the "Q"-band (36-46 kmc.) and provide two overlapping beams, one modulated at 1,000 cps., the other at 2,000 cps., not unlike present lower-frequency ILS localizer. Real estate required for buried leader cable installation is one major objection to the British all-weather landing system.

▶ Russia has started a network of helicopter lines in the Far East as part of its program to have about 7,500 mi. of such routes operating by the end of 1960. New links were established recently in the Vladivostok and Nikolaevsk-on-Amur areas to serve health resorts that are difficult to reach by surface transportation. Ten helicopter routes will be inaugurated by Aeroflot's Far East Administration this year.

SHORTLINES

▶ **British Overseas Airways Corp.** plans to inaugurate Boeing 707-420 turbojet service from New York to Nassau and Jamaica Sept. 24. The Rolls-Royce-powered transports will operate on a weekly basis in addition to BOAC's daily Bristol Britannia turboprop flights. The 707 flights are scheduled for 2 hr. 35 min. to Nassau and 3 hr. 30 min. to Jamaica.

▶ **Federal Aviation Agency** will study the use of parallel runways for simultaneous, independent operations at Chicago's O'Hare International Airport. FAA hopes to be able to determine safety factors and procedures for parallel runway use by next January.

▶ **Federal Aviation Agency** has revised its pilot medical forms to eliminate the requirement that all airmen applicants for medical certificates automatically sign an authorization permitting FAA to obtain additional medical records from personal physicians. Blanket application of the rule has been changed to require such background information only when specifically requested by the agency. The revision applies only to airline and commercial pilots. Private and student pilots have been required to comply with FAA request since 1956.

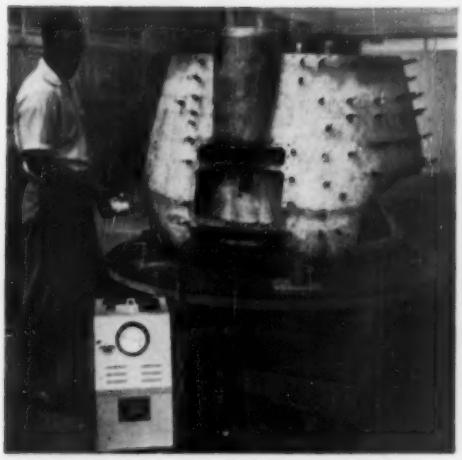
▶ **Hawaiian Airlines** will begin a one-year airlift between California and the Marshall Islands on Oct. 1 under a $1.1 million contract with the Western Electric Company, Inc. Contract covers the movement of personnel and equipment for the Army's Nike Zeus test facilities currently being constructed on Kwajalein Island.

▶ **Northeast Airlines** has reported a net profit of $259,000 during June, compared with a net loss of $545,000 for the same period last year. System load factor for the month reached 62.02%, an 18 month high.

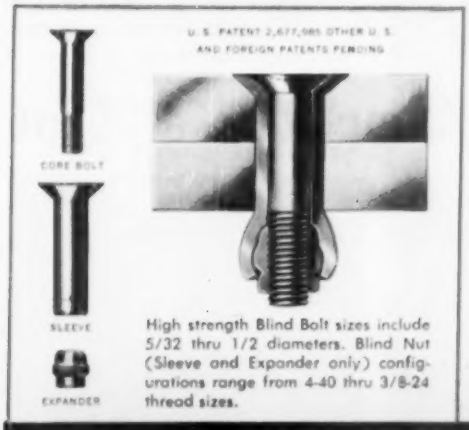
▶ **Pan American World Airways** may get into the hotel business in Ireland through Irish Intercontinental Hotels, Ltd., a company formed by Irish Airlines, Gresham Hotel Co., Ltd., and Intercontinental Hotels Corp., a Pan American subsidiary. New company will make preliminary surveys of the possibility of building hotels in Dublin, Cork and Limerick.

▶ **Pan American Grace Airways** had a 12% increase in its air cargo operations during the first six months of 1960. Cargo traffic totaled 3,226,000 ton miles, and Panagra said the gain reflects an increasing demand for heavy machinery and oil drilling equipment.

SONIC VIBRATION PROBLEMS ON DC-8 SOLVED BY BLIND BOLTS



Above photo shows portable electric-hydraulic Power Unit (3000 psi max....110 v. source) actuating hand held Gun to drive 1200 Blind Bolts in each Ejector and Thrust Brake. Air-Hydraulic Power Units are safely used in flight ramp areas for repairs on fueled aircraft. Hand installation tools are also available.



High strength Blind Bolt sizes include 5/32 thru 1/2 diameters. Blind Nut (Sleeve and Expander only) configurations range from 4-40 thru 3/8-24 thread sizes.

Blind Bolts were finally selected by Douglas DC-8 engineers for use in the Sound Suppressors. Exhaustive tests of various blind fasteners determined that Blind Bolts in temperature areas could best resist overall sound pressure levels reaching 150 decibels!

In this unusual application, the remarkable ability to the Blind Bolt to resist sonic vibrations stems from several of its inherent design features...the *twin locking technique*, combining the oval lock of the Expander to grip the thread of the Core Bolt and the wedge lock between the Expander and Sleeve end...*the hole filling ability*, resulting from the expansion of the Sleeve shank during the installation pull-up of the Expander into the Sleeve end...and lastly, *the excellent fatigue resistance*, gained from the high tensile preload imposed by the Core Bolt and from the cushioning effect of composite fastener materials.

Because the coefficient of expansion must remain the same to prevent loss of fastener preload, the compatability of structural materials at high temperatures is essential. Inside the stainless steel Ejector where exhaust gases reach 900°F., A-286 stainless steel Blind Bolts are used. On the outside where structural temperatures reach 300°F., Type 431 stainless steel Blind Bolts are used.

From the shop viewpoint, Blind Bolts are installed rapidly and quietly. Hole preparation is simple, no reaming is required. Only Blind Bolts offer a choice of gun driving tools designed for repairs or modifications in difficult or tightly congested structural areas.

If sonic vibration is your fastener problem...consider Blind Bolts. Write for brochure.

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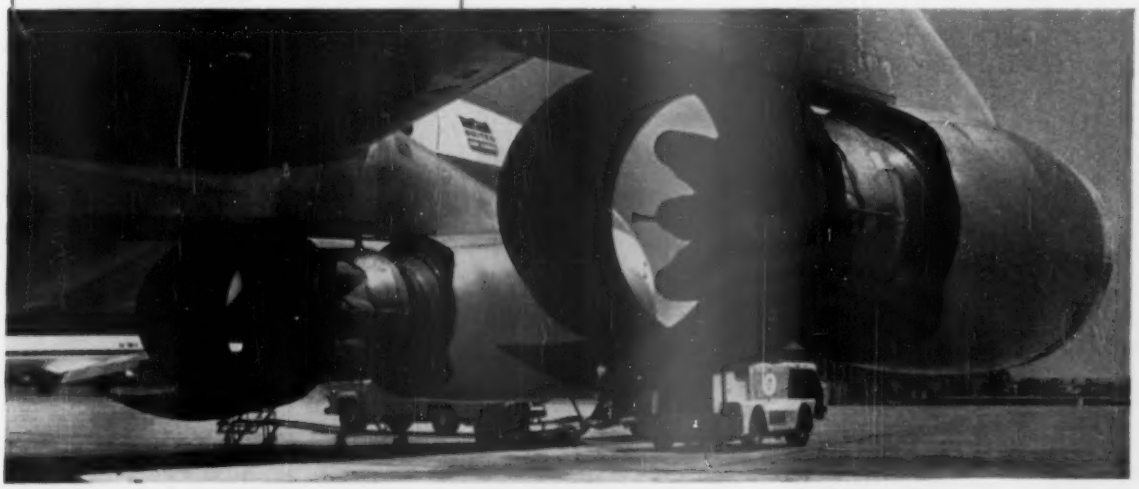
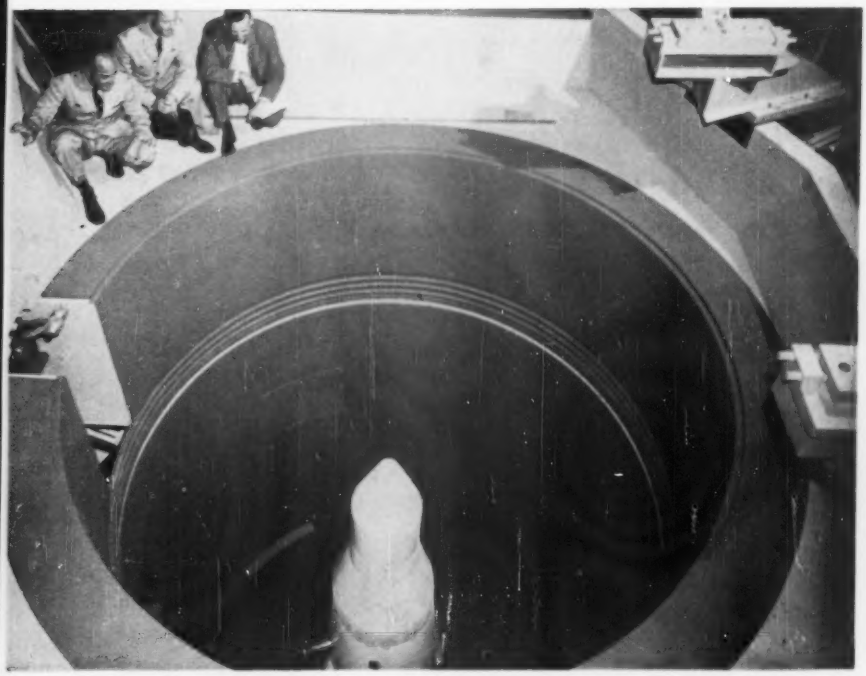
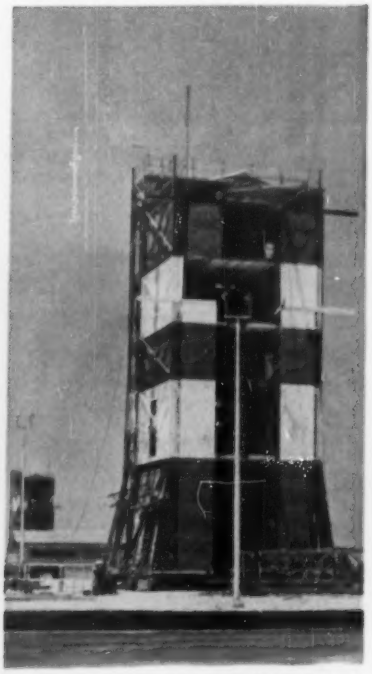


Transporter-erector for Minuteman intercontinental ballistic missile will be used to move the weapon from the assembly and recycle facility to underground silo sites. Unit also will be used to load Minuteman into transport aircraft for airlift to the sites.

Minuteman Launch Site Nears Completion at Cape





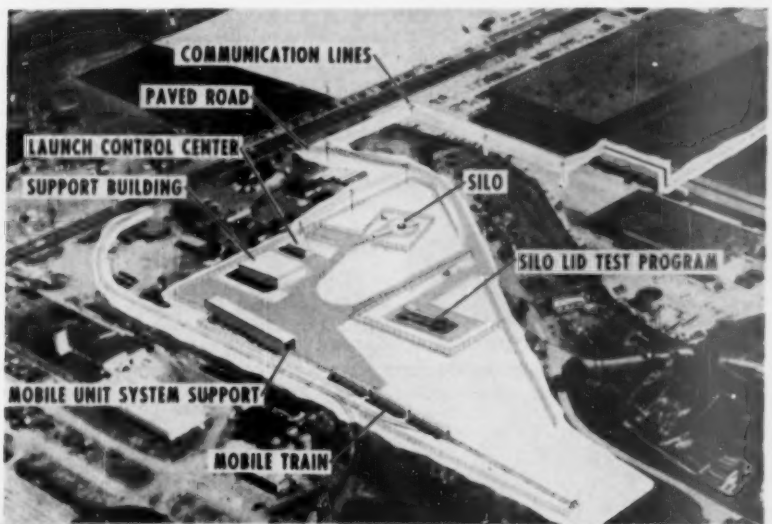
Mockup of Minuteman ICBM launch silo is inspected at Boeing Airplane Co. by (from left) Col. James H. Foster, Ballistic Missile Center; Col. Samuel Phillips, Minuteman program director, and T. A. Wilson, of Boeing. At right is service tower at Cape Canaveral, Fla.

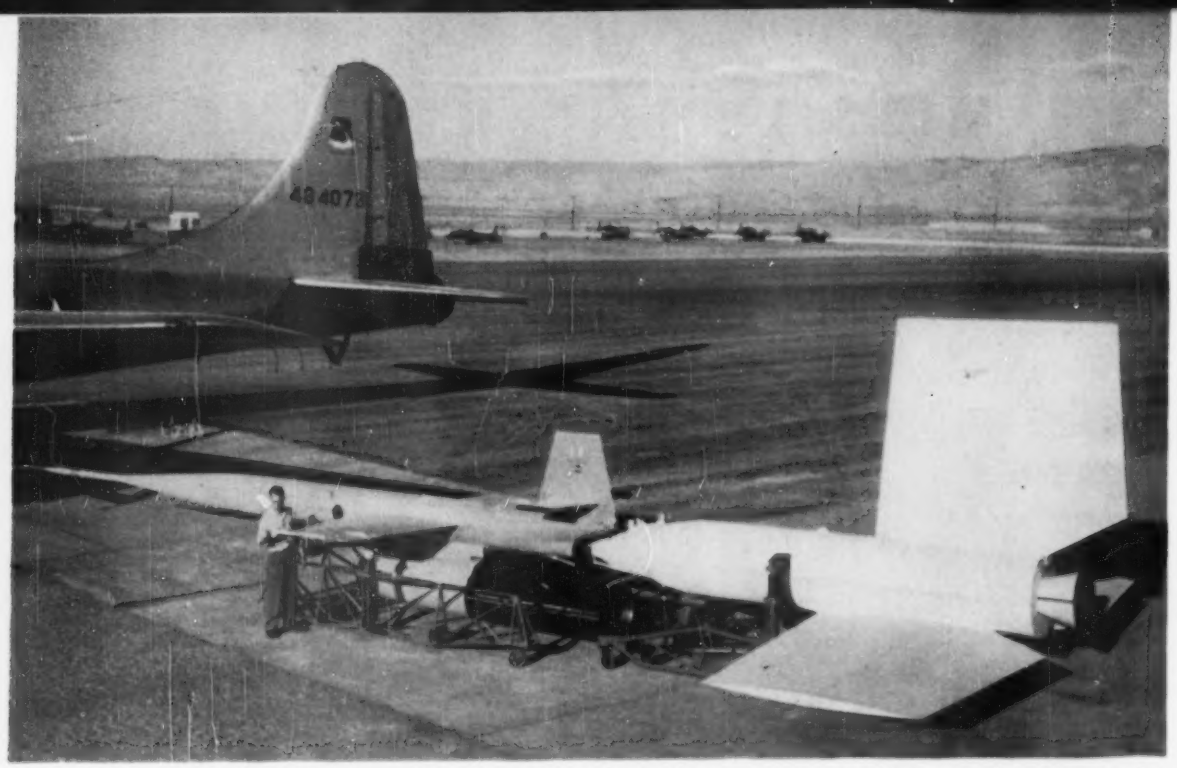
MISSILE ENGINEERING

One of two Minuteman launch silos at Cape Canaveral is in foreground, with blockhouse at left center and service tower at far right.

Initial construction of Minuteman intercontinental ballistic missile launch site at Cape Canaveral, Fla., has been completed at a cost of $7 million. Site consists of two blockhouses, two "flat" launching pads and service towers, two 90-ft.-deep ICBM silos and facilities for assembly, storage, inspection and maintenance. First flight will be made after installation of technical equipment and instrumentation at the launch sites. U. S. Air Force said the first firing will test all three-stages but will not be made from the silo. Boeing Airplane Co. has completed some 3,800 cold-flow experiments on 1/20th and 1/30th scale models, utilizing supercooled compressed nitrogen gas in a small wind tunnel. Test model also has been used in about 40 acoustic tests to measure the noise level in the silo. General configuration of Cape Canaveral site is shown at lower left; at lower right, Maj. Gen. O. J. Ritland, BMD commander, and Col. Phillips inspect a test console.

Blockhouse for Minuteman control is 29 ft. high and is part of $7 million flight test facility at Cape Canaveral. First Minuteman launch is set for December. Launch control is on first floor level; second level has a ready room, evaluation room, power supply center.





LOCKHEED X-7 test vehicle, loaded on ground handling vehicle, is fitted with rocket booster. Vehicle has gained ramjet engine data at speeds as high as Mach 4.31 and altitudes up to 106,000 ft. Program included 26 test vehicles.

X-7 Program Builds Ramjet Test Data

LOCKHEED X-7A-3 undergoes systems checkout at company's Van Nuys, Calif., facility. Note exceptionally rugged steel structure which permitted average of five flights per vehicle and up to 12 flights for a single craft.

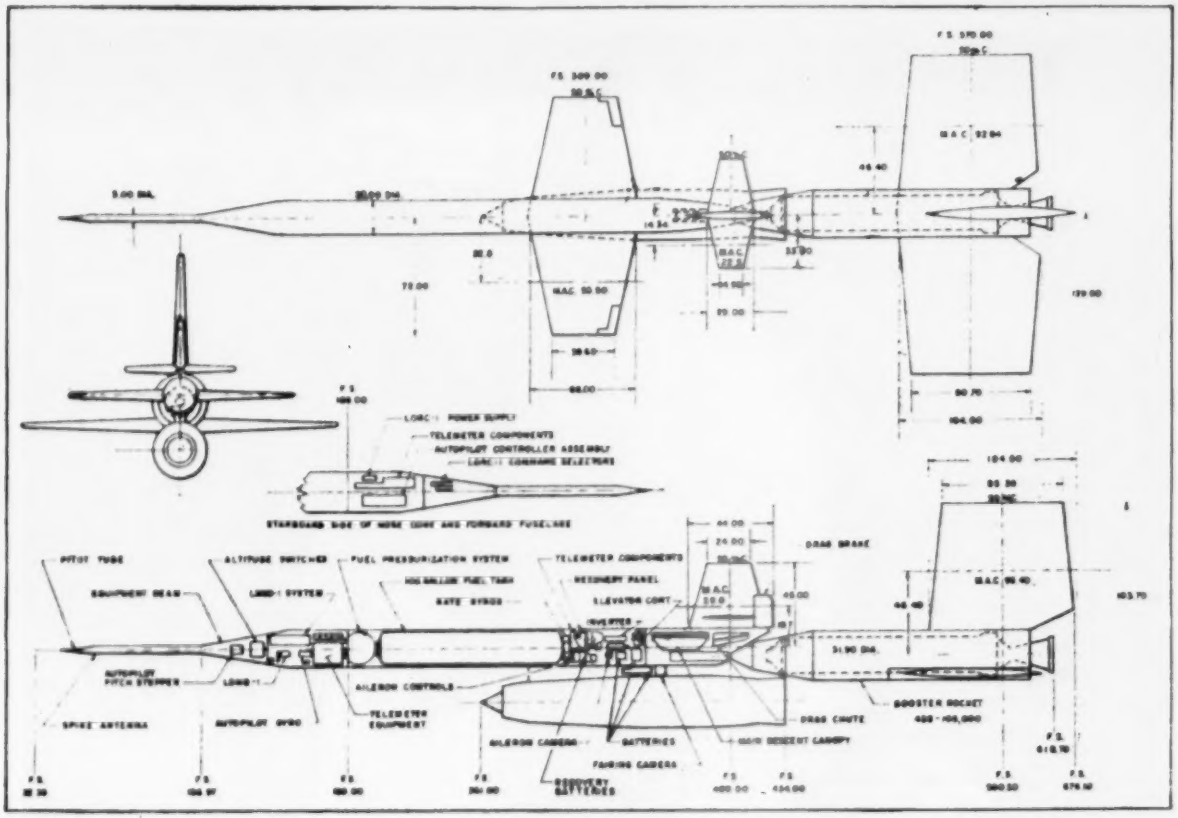
By William S. Reed

Van Nuys, Calif.—Ramjet engine testing in high speed, high altitude flight by the Lockheed X-7 test vehicle has gained data at speeds as high as Mach 4.31, altitudes to 106,000 ft. and skin temperatures to 700F.

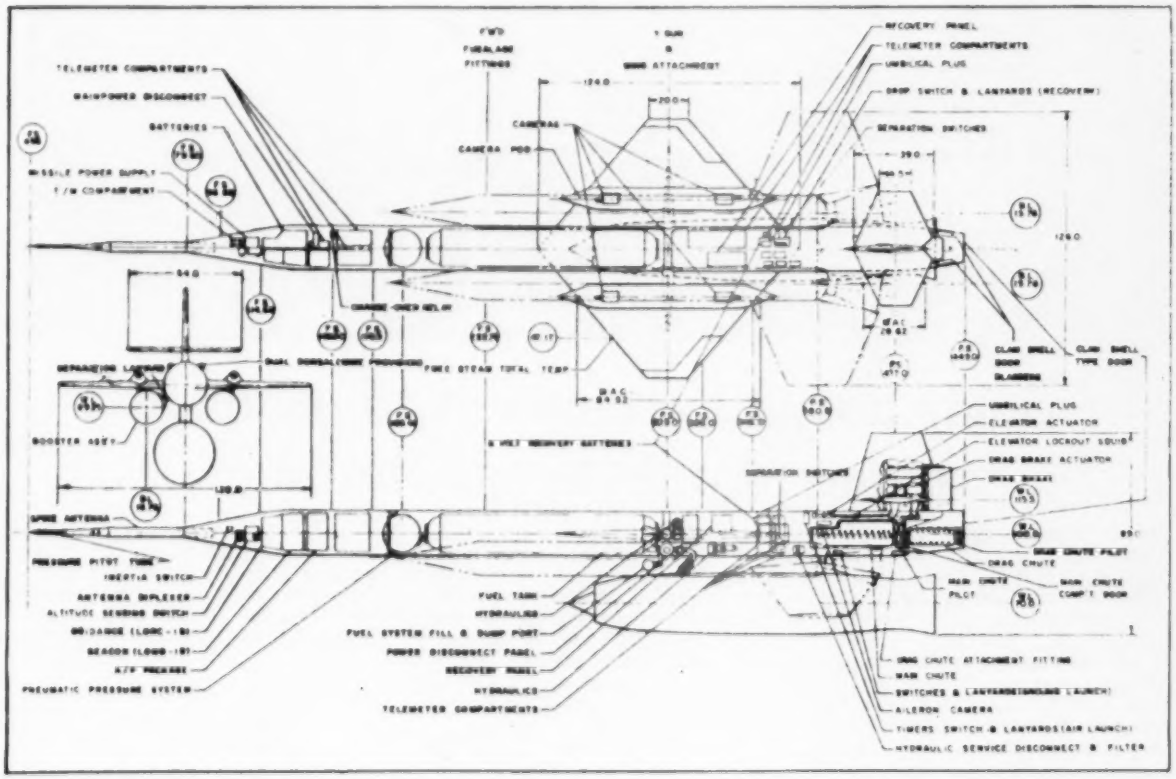
The entire program was conducted with the expenditure of 26 vehicles which made a total of 130 flights at Holloman AFB, N. M. Although Lockheed Missiles and Space Division, builder of the X-7, feels areas of interest still exist for the vehicle, the program ended with the July 20 flight.

During the nine-year program, primary emphasis was directed at exploring performance and operating limitations of variously configured Marquardt ramjets. Lockheed's participation consisted of providing a platform capable of putting the engine in the air at a specific altitude and speed. Primary concern was to establish the envelope in which ignition would occur in the ramjet engine, since combinations of shock wave position and dynamic pressure must be met for proper starting.

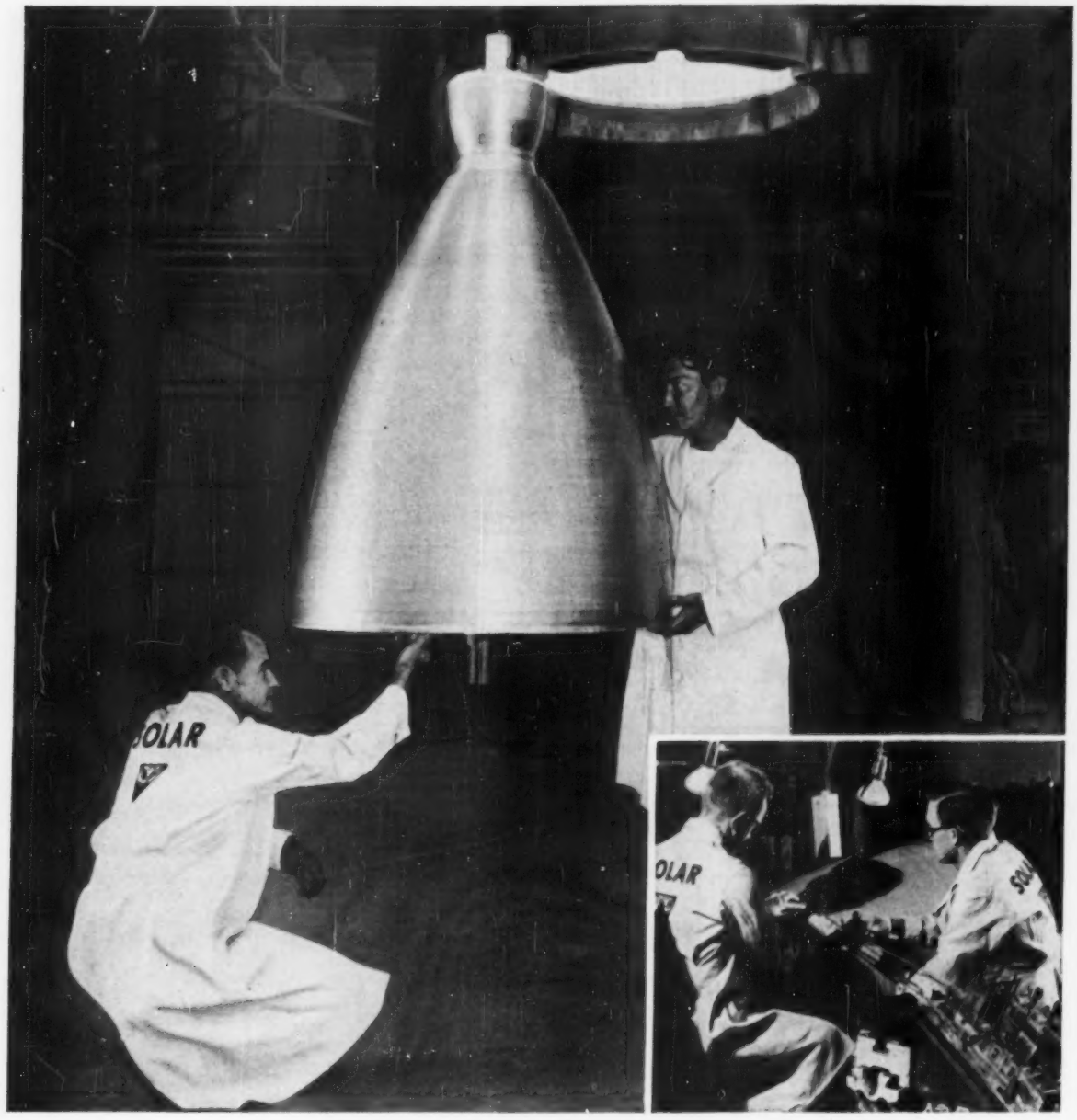
Lockheed developed an unusual recovery method for the X-7 to ensure that the engine returned intact from each flight. Final form of recovery decided on was a five-stage parachute system consisting of a high speed drag



PLANFORM of the Lockheed X-7A-1 is detailed above; note booster emplacement and facilities for camera installation.



DRAWING shows details of the X-7A-3 test vehicle configuration. The -3 model was carried aloft in a B-50 bomb bay.



Solar uses new concept to produce unique liquid thrust chamber

UNIQUE FURNACE-BRAZED thrust chambers are being manufactured by Solar Aircraft Company to withstand the extreme heat flux of new high-energy liquid propellants.

Under contract to the National Aeronautics and Space Administration, Solar is utilizing a "ribbon-wrapping" process—involving new materials and brazing techniques—to fabricate chambers that are lighter, stronger and less expensive to produce.

The chamber shape is achieved by spot welding 360 U channel strips of .008 in. AM350 stainless contoured to the desired configuration. After a precision grinding process, the chamber is "wrapped" with approximately half a mile of stainless steel ribbon and brazed at temperatures up to 1980F in one of Solar's large 600 kw elevator-type brazing furnaces.

The sheet metal channels provide a precise method for controlling coolant passage area throughout the chamber.

Solar is a recognized leader in applying new materials and new metal-working techniques to difficult problems of the space age. For information, write to Dept. H-155, Solar Aircraft Company, San Diego 12, California.

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chute and a main chute with three reefing stages prior to full blossom. A nose spike shrouded by telemetering antennas and a tapered nose cone penetrated the ground, with impact being absorbed by designed-in collapsing of the spike.

X-7s appeared in two basic versions: the X-7A-1 and the X-7A-3. The former was carried aloft under the wing of a B-29 and launched to ignition altitude by a single rear-mounted booster. The wing planform and geometry was very close to that of the F-104, which, in fact, was evolved from the X-7. The A-3 had a wing planform similar to the Boeing Bomarc and was proposed by Lockheed in competition with it. It featured two underwing-mounted booster rockets and was carried aloft in the bomb bay of a B-50.

Requirements of the mission of the X-7 dictated that it be constructed entirely of steel to withstand aerodynamic heating and to be rugged enough to permit reuse. Maximum speed of Mach 4.31 was reached at 60,600 ft. with skin temperatures of 700F generated at this velocity.

Ultimate load limits to which the aircraft was designed were plus 13g and minus 6g. Such high load limits were necessitated not only by the requirement of the high stresses imposed by recovery and aerodynamic heating, but for maneuvering in flight to investigate the effects of varying angles of attack, attitude, accelerations, etc. on engine performance. Programed into some of the flights, in addition to high angles of attack, were aerobatic maneuvers such as 360 deg. rolls.

All external parts of the X-7 were built of 4130 steel with the exception of the aerodynamically balanced ailerons and the speed brake doors which were of magnesium. The X-7 is not equipped with a rudder and features a stabilator similar in design to that incorporated in the F-104.

Structural Design

Main structural member of the craft is a forged and milled steel bulkhead which carries the wing attachment points, engine thrust and booster loads, and the fuel tank aft mount. Fuselage is a monocoque structure 20 in. in diameter. Instrumentation trays, arranged cruciform fashion, extended aft from the nose spike about 6 ft. At this point was anchored a sphere containing nitrogen at 3,000 psi. for inflating a bladder for fuel tank pressurization. Aft of the fuel tank, some telemetry was carried but this space mainly was devoted to ship's system equipment including: hydraulics for flight control/actuation, batteries for electrical power, recovery components and parachutes.

The wing was built up in conventional fashion with the main spar at mid-chord which also is the maximum thickness point.

Skin was applied over ribs and flush riveted to the structure. Wing thickness was 4%.

The later version, X-7A-3, had two large fairings about one-third out on each wing semispan which contained camera pods. The A-1 carried camera pods on the wing tips in smaller fairings called "shoeboxes."

Engine operation was divorced from the airframe in that no power was tapped off from the engine to run any of the aircraft systems. Batteries were used exclusively to power the electrically driven hydraulic pumps, for fuel pump operation and for telemetry. Lockheed engineers say that their responsibility to the engine was to deliver fuel at a specified pressure and volume to the engine, and to put the engine into a precise spot in space at a prescribed attitude, Mach number and altitude.

The ramjet vehicles normally were air-launched but there is one case where one was ground-launched. After drop, boosters were ignited and the vehicle propelled to a predetermined altitude and airspeed. Booster power then was terminated, the boosters jettisoned and the ramjet engine ignited.

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Other recently developed methods for improving steels and properties of the improved alloys are described in a new booklet, "Modern Melting at Allegheny Ludlum." It includes a description of Special Air Melted Steels, Invac alloys made by induction vacuum melting, Invacutrode alloys made by remelting Invac electrode stock by the consumable electrode vacuum process, and Consutrode alloys.

This new booklet is packed full of charts and graphs—a real help to anyone who must get the most out of metals. Ask your A-L representative for a copy or write: ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pennsylvania. Address Dept. AW-9-1.***

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Weight at the time of ramjet ignition was between 3,500 and 4,000 lb. depending on the nature of the test and the fuel load.

Fuel Limitation

Due to range limitations and fuel capacity, only one pass was made over the Holloman range, after which the aircraft was manuvered to the recovery area and the parachutes deployed. Residual fuel was dumped at the time of chute deployment to make the vehicle as light as possible on impact with the ground.

Average life of the X-7 was five flights but one vehicle made 12. First flight of an X-7 took place in April, 1951, and, according to a Lockheed engineer, "was reasonably successful, considering the range was littered with fragments in a matter of seconds after the bird was launched."

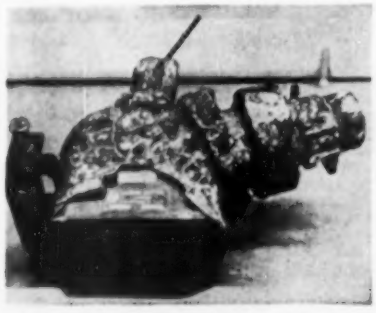
It was nearly 13 months later that the sixth attempt produced a successful flight but the program did not reach full stride until 1954. Part of the explanation lies in the type of equipment with which the engineers had to work.

Telemetry Equipment

Commercially-made telemetry equipment such as is available today, was not on the market t that time. Lockheed had to enter into a development program of its own and many makeshifts were employed.

One example was the early use of surplus parking meter clocks as sequence timers.

Vibration testing was conducted by mounting the vehicle in a test rig and applying a jack hammer to the airframe. Acceleration forces produced by the booster engines were simulated by what Lockheed refers to as a "g-shooter"—a pneumatic piston which applied loads to the airframe at the booster attach points.



Coating Resists Blast

After exposure to blast during Atlas launch, portion of high temperature coating manufactured by Dyna-Therm Chemical Corp. was cut away to expose identification on electrical connector above. No scorching or other apparent damage was found.

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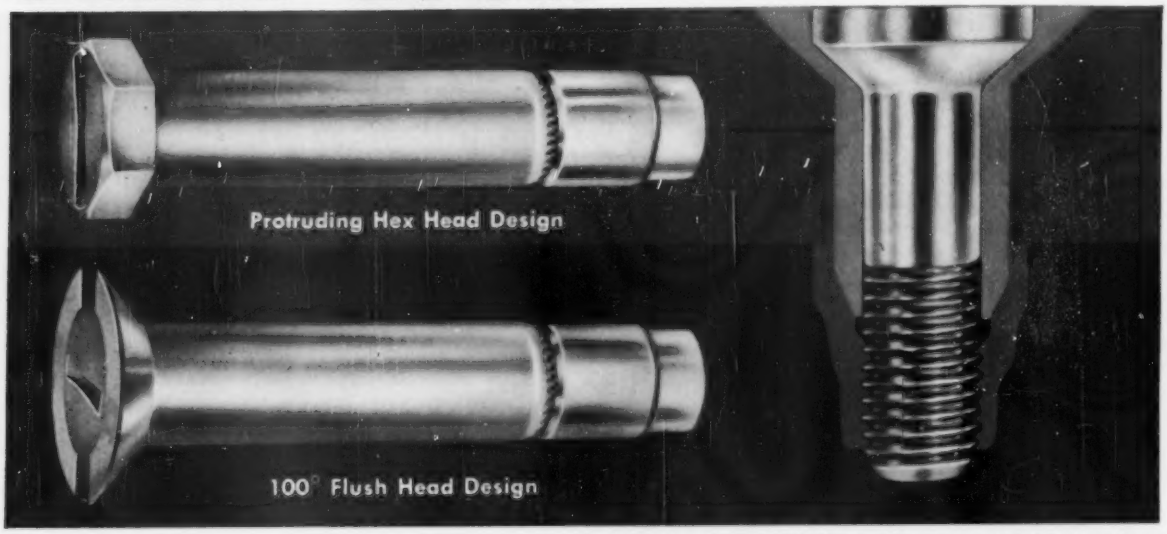


SPS SLEEV-LOCK blind fastener is a preassembled 3-piece shear bolt consisting of an outer sleeve with a Hi-Torque* recessed-head core bolt running through it and engaging an expansible nut.

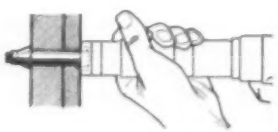
One man, working from the head side only, can install up to 25 SLEEV-LOCKs a minute—a rate 50% faster than with most comparable fasteners. SLEEV-LOCK is simple . . . comes preassembled . . . fits standard holes . . . drives with standard power tools fitted with inexpensive adapters.

SLEEV-LOCK performance exceeds that of NAS solid shear bolts heat treated to 160,000 psi, permitting size-for-size substitution. In repair work, this frequently allows quick replacement of conventional nut-and-bolt combinations that would present major dismantling and reassembly problems.

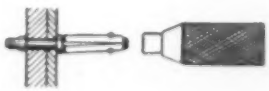
Also you can remove SPS SLEEV-LOCK blind fasteners without drilling or damage to the work. Simply run the expansible nut off the core bolt and remove the sleeve from the same side of the work on which it was originally installed.

SLEEV-LOCKs are available in sizes 3/16 through 3/8 inch in .062 inch grip increments. For complete data on SPS SLEEV-LOCK blind fasteners and SPS SLEEV-LOCK power drivers and adapters, request Bulletin 2465. Write AIRCRAFT/MISSILE Division, SPS, JENKINTOWN 3, PENNSYLVANIA • SANTA ANA, CALIFORNIA.

Inserting: Preassembled SLEEV-LOCK is inserted from one side of work. Can also be press-fitted in an undersize hole if desired . . . nut will not interfere.



Driving: Simple adapter on power driver holds sleeve stationary while turning core bolt, thus drawing nut over sleeve and clamping work tight.



Removing: After breaking lock by momentarily reversing driver, insert special bit in Hi-Torque recess of core bolt. SLEEV-LOCK does not have to be drilled out to be removed.

Core bolt is easily withdrawn by gripping bit with barrel-handle assembly. Sleeve is then pulled from hole with pliers or with an Easy-Out type of tool.

*One or more U.S. and foreign patents

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Curtiss-Wright Begins Project Reorientation

Reorientation of Curtiss - Wright Corp. promised by its new chairman, T. Roland Berner, (AW June 13, p. 30) began to take form recently. The company:

• **Sold** Santa Barbara, Calif., division plant to the Defense Products Division of General Motors Corp. The GM research and development division plans an extensive program dealing with underwater instrumentation at the facility. The plant was acquired by Curtiss from the Studebaker-Packard Corp.

• **Sold the products** and business of its Curon Division, which manufactures foamed and molded plastic products, to Reeves Bros., a company engaged in textile work.

• **Reshuffled** its research programs within the company, a step which includes strengthening the potentials of the Curtiss-Wright Quehanna, Pa., research center.

Some electronics, ultrasonics and propulsion projects from the Aerophysics facility will be transferred to Quehanna, for example. The Skydart target drone program will move to one of the company's New Jersey production divisions.

The Curtiss VZ-7AP ducted fan project, a Santa Barbara endeavor, is no longer being funded by the Army.

Curtiss gave the four megawatt swimming pool reactor at Quehanna to the Pennsylvania State University to supplement the university's nuclear programs and promote fuller cooperation between the company and the university, the company said.

Key personnel from the Aerophysics and Curon operations were transferred to other divisions of the company. Production workers at Santa Barbara—where total employment was about 250—will be laid off, but may find jobs with the General Motors Division. Some of the 200 people in the Curon Division were absorbed by other Curtiss-Wright operations.

About 300 people are employed at Quehanna now, Curtiss said.

Berner had promised when he succeeded Roy T. Hurley as chairman that certain unprofitable lines would be eliminated, a reference to the Curon operation.

He had pointed out then that Curtiss would do no further flirting in the consumer field, in which the company had little experience.

Curtiss will continue its work in the nuclear components field, and is negotiating contracts with other companies for the supplying of beryllium oxide components that "provide unusual performance at temperatures in excess of 3,000F."

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APPLICATION

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When completed in 1961, this will be the first Air Force facility of its kind. Control rocket systems will be tested at altitudes in excess of 100,000 feet.

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Detailed information about the Division's experience, facilities and services may be obtained by writing for Marquardt's new Facilities Engineering capability brochure. Address your inquiries to: Tom Hudson, The Marquardt Corporation, 16555 Saticoy Street, Van Nuys, California.

Engineers and Scientists experienced in these or related fields will find it rewarding to discuss their career futures with Marquardt. Founded in 1944, Marquardt now has a staff of 5,000—two out of three are professional people. The company's growth is a parallel to the atmosphere of challenge and rewarding accomplishment that has existed since the firm's beginning.

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Mobile Propellant Supply Systems Studied

By J. S. Butz, Jr.

Washington—High performance nuclear and chemically fueled rockets scheduled for development during the 1960s will require an increase in current cryogenic propellant supply capacity and possibly large mobile propellant production facilities to achieve the overall maximum launch economy and flexibility.

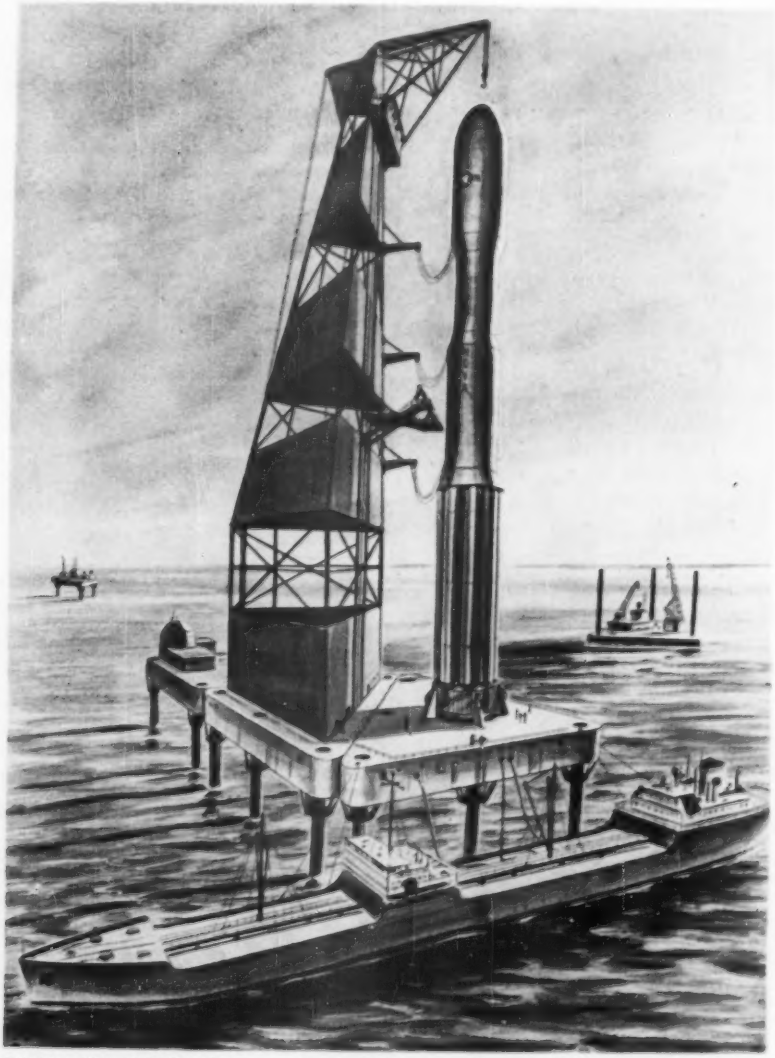
Three general supply plans are being studied by government agencies and industry to service 6 million lb. thrust Nova-class vehicles, which are due for flight testing in 1968. They will carry a total of approximately 4,150,000 lb. of propellant, including about 3,200,000 lb. of cryogenic liquids, compared with an ICBM propellant load of about 200,000 lb.

These propellant supply plans are the following:

• **Manufacture of liquid** hydrogen and liquid oxygen propellants at the launch site in a large land-based facility. Hydrocarbon RP-1 fuel, which is relatively unaffected by temperature, is now scheduled for the first stage of Nova-class vehicles and would be handled by conventional means and kept for long periods in storage tanks at the launch site.

• **Transfer of cryogenic propellants** to the launching base by tank cars or through pipelines after manufacture at an inland plant.

• **Manufacture and storage** of propellants aboard sea-going tankers. A number of vessels in U. S. Merchant Marine and several auxiliary vessels used by the Navy have the necessary volume to house equipment for the manufacture of liquid hydrogen and liquid oxygen, and to store these propellants and RP-1 fuel in quantities needed by rocket vehicles three to four times larger than the Nova. Manufacture of the cryogenic propellants in a 15 day cycle or less would require that a 200 mw. nuclear reactor be carried aboard the ship if a large outside source of fuel was not available. Sea water would be the raw material used to produce the propellants.



SINGLE SEA-GOING tanker equipped with cryogenic propellant manufacturing and storage systems and hydrocarbon fuel storage space could supply more than 14 million lb. of propellant for the launch of the largest space vehicles being considered for construction during the next 15 years. Texas tower type installations would allow launchings at equator and in isolated areas to minimize the hazards of carrying nuclear-powered upper stages.

Tanker Studies

Martin Co. is one of the firms studying the tanker concept to meet the requirements of nuclear rocket testing as well as those of the 2,500 ton Nova-class vehicle. In addition to its independent studies in this area, Martin holds a National Aeronautics and Space Administration contract to investigate the problem of flight testing the first nuclear rocket engines which will be developed under the Rover program. The first Rover flight tests are expected in four to six years.

Exact method of launching rockets which carry nuclear reactors has not been settled, regardless of the purpose of the reactor. This includes reactors which are part of the propulsion system of the launch vehicle, and those which are carried to provide auxiliary power in space.

One of the major questions is whether nuclear reactor systems should be launched from existing ranges or from remote sites. Some officials responsible for such nuclear devices feel that they should be launched from remote sites to minimize any radiation danger in the event the launch vehicle fails catastrophically. Most experts also favor placing all rocket-launched nuclear reactors into orbit before they are operated and brought up to power.

First Rover Engines

The first Project Rover engines are scheduled to be flight-tested in the upper stages of a Saturn vehicle and will not be operated until they are in a stable orbit.

If it is decided to use isolated launch sites for rockets carrying nuclear reactors, then mobile propellant manufacturing facilities almost become a necessity. These sites probably would be

small uninhabited islands or Texas tower type platforms located off the main sea routes. Purpose of the isolated sites would be defeated if they included elaborate permanent installations which might be damaged or rendered useless for long periods if contaminated by radiation during a serious accident.

These isolated sites would be little more than permanent launch pads and support towers. Most of the instrumentation, launch controls and tracking equipment, as well as the propellant supply facilities, would be shipborne.

Floating propellant supply facilities become more attractive for use with chemically fueled vehicles as the vehicle size increases. The largest Saturn rocket, for example, has about five times the propellant load of an ICBM and would tax any supply system transporting propellants to the launch sites in trucks or rail tank cars. Each Saturn launch would require 34 truckloads or 11 tank carloads of propellants (see table).

Nova-class vehicles would need about 150 truckloads or 44 rail carloads at each launch. These vehicles are now being funded by NASA, and their gross weight range has been fixed even though a definite configuration has not been selected.

Chemical Fuels

Preliminary design studies of vehicles beyond the Nova-class show that chemically fueled rockets up to 20 million lb. may be attractive for many space missions. Floating propellant facilities or propellant manufacturing plants at the launch site would be mandatory for these vehicles. The floating facilities would have the following primary advantages:

- **Several launch sites** could be supplied by a single propellant manufacturing and storage tanker. Launch of 15 million lb. vehicles would be rather infrequent, and the tanker could service all current U.S. launch sites and any equatorial or isolated sites now contemplated.
- **Loss of cryogenic propellants** during holds in the countdown would be minimized by fueling from a large volume tanker. Boil-off rate decreases as the volume of the propellant increases and it would be possible to circulate the propellants between the missile and a refrigation system in the ship to increase the effective volume.

Martin studies of a typical propellant supply tanker converted from an existing vessel show that it would be possible for it to service 20 million lb. gross weight vehicles. The vessel would manufacture and store 10 million lb. of liquid oxygen and 750,000 lb. of liquid hydrogen and carry 3.25 million lb. of RP hydrocarbon fuel. The manu-

PROPELLANT manufacturing and storage tanker proposed by the Martin Co. is shown above supplying a permanent launch site on the mainland.

VARIETY of launch sites for large space vehicles could be supplied by sea-going tankers which manufacture and store propellants. Martin Co. has proposed such tankers equipped with 200 mw. nuclear reactors to provide power for the propellant manufacturing operation. Launch site above is a small, uninhabited island with few permanent facilities.

Propellant Requirements

	Thrust	Availability Date	Propellant Required
ICBM	300,000 lb.	now	200,000 lb.
Saturn	1.5×10^6 lb.	1961–1962	1×10^6 lb.
Nova	6.0×10^6 lb.	1968–1970	4.15×10^6 lb.
Future	20.0×10^6 lb.	1972–1975	14×10^6 lb.

PROPELLANT LOGISTICS

Method of Supply	Present Capacity	Future Capacity	Tanker Vehicles Required: ICBM	Saturn	Nova	Future
Truck Tank Car	3,000 gal.	3,000 gal.	7	34	150	490
Railway Car	10,000 gal.	10,000 gal.	3	11	44	148
Sea-Going Tanker		Navy Oiler (AO)	1	1	1	1
On Site Mfg. & Storage		20,000 lb. plus as Required	0	0	0	0

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4253-01*	LZ-CT	11.8	.087	.21	23.5	9.0	157.0	24.0	212+j722	28+j119	263+j69	30	±7
4269-01*	Diff	11.8	.087	.21	11.8	9.0	35.0	24.0	37+j139	28+j124	47+j13	30	±7
4273-01**	XMTR	26.0	.100	.54	11.8	8.5	34.0	12.0	48+j255	12+j45	82+j31	30	±7
4277-01*	HZ-CT	11.8	.030	.073	22.5	8.5	316.0	67.0	500+j1937	79+j350	594+j182	30	±7
4261-01**	Resolver	26.0	.043	.39	11.8	15.0	162.0	22.0	208+j612	34+j159	243+j77	30	±7

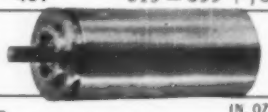
*Stator as Primary **Rotor as Primary

SIZE 8

SERVO MOTORS

OSTER TYPE	RATED VOLTAGES	Z = R + jX	IN. OZ. STALL TORQUE	RPM NO LOAD SPEED	WATTS PER PHASE	GM. CM. ROTOR INERTIA	LENGTH IN. MAX.	WEIGHT OZ.	T/I RATIO RAD/SEC²
5004-01	26V 26V	288 = 226 + j 176 294 = 238 + j 174	.15	6200	2.0	.47	0.863	1.2	22,500
5004-02	26V 36V	288 = 226 + j 176 526 = 409 + j 332	.15	6200	2.0	.47	0.863	1.2	22,500
5004-03	26V 40V	288 = 226 + j 176 715 = 582 + j 415	.15	6200	2.0	.47	0.863	1.2	22,500
5004-09	26V 40V	230 = 190 + j 131 519 = 399 + j 332	.20	6200	2.5	.47	0.863	1.2	30,000

SIZE 8



MOTOR TACH-GENERATORS

OSTER TYPE	RATED VOLTAGES	Z = R + jX	IN. OZ. STALL TORQUE	RPM NO LOAD SPEED	WATTS PER PHASE	GM. CM. ROTOR INERTIA	LENGTH IN. MAX.	WEIGHT OZ.	T/I RATIO RAD/SEC²	GENERATOR VOLTAGE	INPUT WATTS	OUTPUT VOLTS PER 1000 RPM
6204-01	26V 40V	230 = 190 + j 131 519 = 399 + j 332	.20	6000	2.5	.65	1.728	2.5	21,800	26	2.5	.25
6204-03	26V 26V	230 = 190 + j 131 230 = 190 + j 131	.20	6000	2.5	.65	1.728	2.5	21,800	26	2.5	.25

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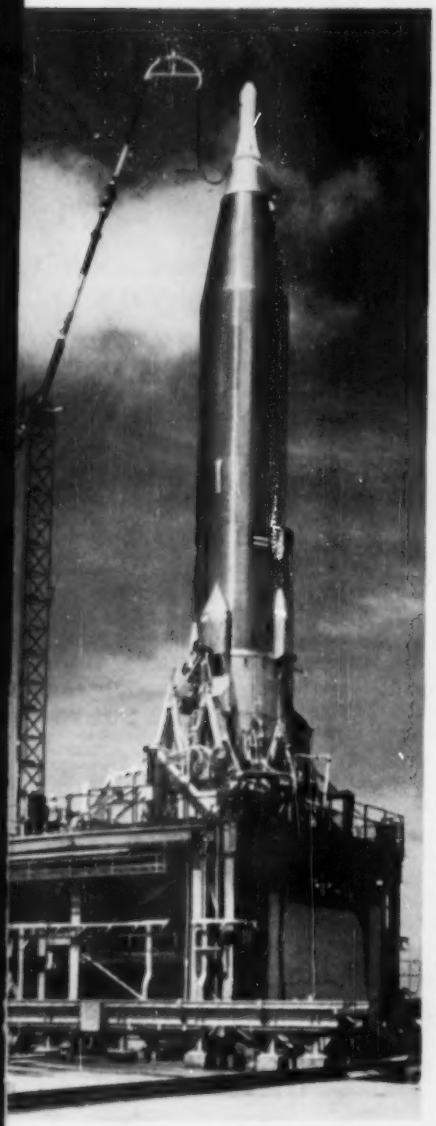
facturing process would be the electrolytic decomposition of water because of the availability and cheapness of the necessary raw material. This process is not the most economical from a power consumption standpoint, but the use of a nuclear reactor overcomes this disadvantage somewhat and also makes the tanker a self-contained unit without need for external power during the propellant manufacturing phase of its operation.

In the Martin concept, this tanker would also be able to provide many other services and materials at a launch site, such as large amounts of fresh water, electrical power and pumping capacity.

The tanker's propellant manufacturing machinery would include a large purification unit to distill sea water for use in the electrolysis process, electric generating equipment for this process and large volume pump.



Atlas Launched on 7,000-mi. Flight

USAF-Convair Atlas D ICBM is tested (left) before being launched (right) on a 7,000-mi. flight from Cape Canaveral, Fla., to a programed impact in the South Atlantic Ocean (AW Aug. 15, p. 37). Missile, carrying a General Electric Mk. 3 nose cone, attained an apogee of 1,000 mi. on Aug. 9, compared with the usual 500-600 mi. apogee of an ICBM on a 6,000-mi. flight. The high apogee extended the time available for gathering data on heating, loading and ablation of the operational-type re-entry vehicle. Recovery of the nose cone was not planned or attempted. Two Douglas JC-54s and an ocean range vessel from Air Force Missile Test Center patrolled the impact area to ensure that ships kept clear. These craft also were used to receive telemetered data on performance of the re-entry vehicle.

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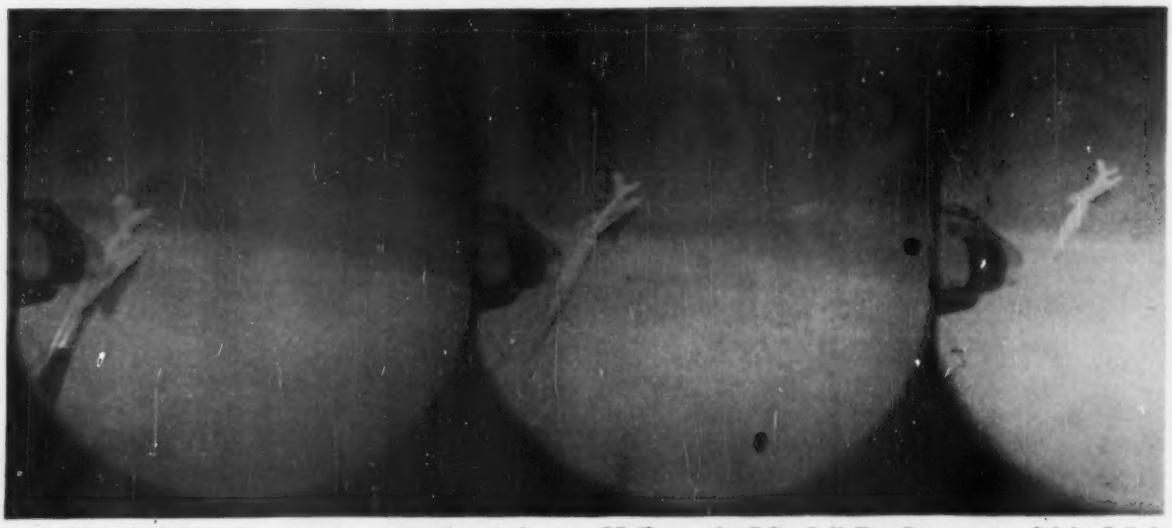


CLOSE TRAJECTORY of a Bomarc interceptor missile as it dives on QB-47 over the Eglin Gulf Test Range is recorded by Bell & Howell optical scoring system mounted in camera pods under the drone target's wings. Sequence is right to left.

QB-47 Improves Bomarc Targeting Ability

By Erwin J. Bulban

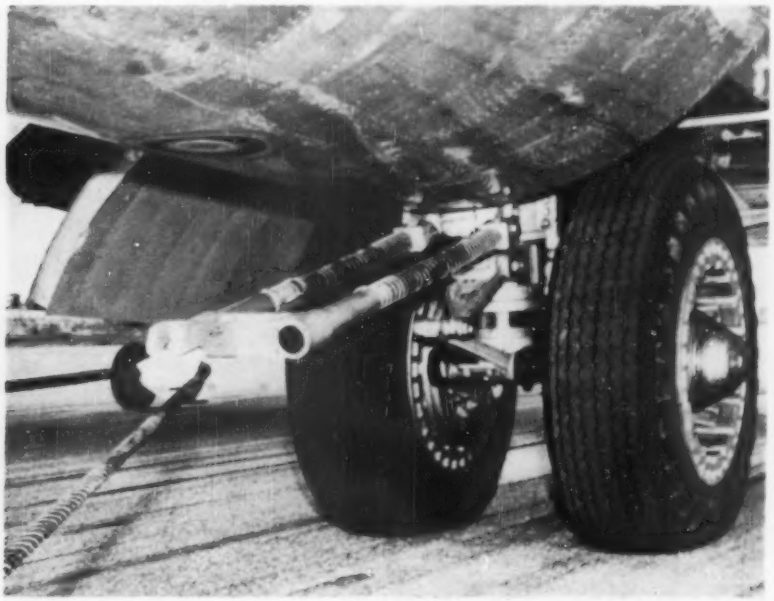
Eglin AFB, Fla.—Boeing QB-47 drone system is providing USAF's Eglin Gulf Test Range with increased targeting capability for the Boeing Bomarc A and B interceptor missiles being exercised here.

Such capability is needed for collection of precision data required in development and writing of tactical employment doctrines for the missiles and the proficiency training of their squadrons.

According to officers of the Air Proving Ground's Drone and Targets Test Branch, which developed the QB-47 system in cooperation with Lockheed Aircraft Corp.'s Marietta, Ga., Division and Sperry Gyroscope Co., features of the new drone include the following:

- **Its size provides** Bomarcs with an accurate target representative of manned offensive bomber systems without need for electronic augmentation.
- **Duration** of about 5¼ hr. gives considerable flexibility in the event of missile holds during a mission due to weather, traffic or equipment malfunctions. It also makes possible scheduling of several firings during a single mission.
- **Payload capability** permits installation of more intricate scoring and countermeasures systems than is possible in smaller targets.

Program calls for 12 production and two prototype QB-47s. Until recently, four had been delivered and were operational at Eglin, but in mid-August, a Bomarc inadvertently scored a direct hit on one of the six-jet targets.



CABLE engagement hook is fitted between the rear wheels of the QB-47. Hydraulically operated brake pucks press against stainless steel rails to halt the aircraft.

Extensive Modification

Indications are that when USAF initially considered the Stratojet as a target system, belief was that conversion would have been a comparatively simple Class 5 modification. But it became apparent as parameters for the system developed that considerable equipment engineering was required.

Program was initiated in December, 1958, with award of a prototype contract to Lockheed's Marietta, Ga., Division, and flight tests were made in May, 1959. Operational capability was attained last July.

The QB-47 drone system as operated here by the 3205th Drone Group con-

BOEING QB-47 target drone is landed at Duke Field by ground controllers atop MRW-5A following Bomarc intercept mission. Controllers atop truck split QB-47 throttle, elevator and rudder functions; airman at side of truck monitors complete drone panel.

sists of an RB-47E reconnaissance version of the Stratojet, selected because this configuration lent itself more readily to "black box" placement than the conventional strategic bomber version; a Lockheed DT-33 director aircraft; countermeasures and scoring systems; a terminal director; a range director; and ground support equipment.

The QB-47 retains RB-47E performance capabilities including provisions for crews for manned missions and ferry operations. For safety pilot checkout of its control equipment, there is a duplicate of the remote control station UHF command control unit installed, with omission of the distrust capability.

Primary guidance commands for control of the QB-47 are taken in through dual AN/ARW-64 UHF radio receiver equipment. Command functions initiated by the ground or airborne director are added to the basic stabilization system to provide complete normal maneuvering control, and to the basic aircraft subsystems to handle auxiliary functions such as landing gear, flaps and brakes. The UHF command link also actuates the scoring and countermeasures equipment.

The Lockheed DT-33 director aircraft has full UHF radio guidance control through the basic AN/ARW-65 transmitting equipment. The control operator is provided with 12 channels of telemetered flight data through an AN/UKR-2 telemetry system, giving him seven proportional and three on-off items of drone flight data. Telemetry system is designed to provide in-flight calibration for signal checking.

For primary drone control during preflight, takeoff, approach and landing phases, two "beeper" pilots control the aircraft from the top deck of an MRW-5A, one handling the QB-47's elevator functions and the other its rudder. Because of the short field with only 8,000-ft. of usable runway, water injection takeoffs are made. Since the heavy dark smoke obscures the airplane's path from the site of the MRW-5A controllers, a second remote station providing azimuth is located in the Duke Field tower to maintain visual contact with the drone and make

SPECIAL arresting gear lessens hazards of remote control of six-jet QB-47. All-American Engineering Co. built and installed the system, comprising a one-inch cable attached to connecting pulley and gearbox mechanism.

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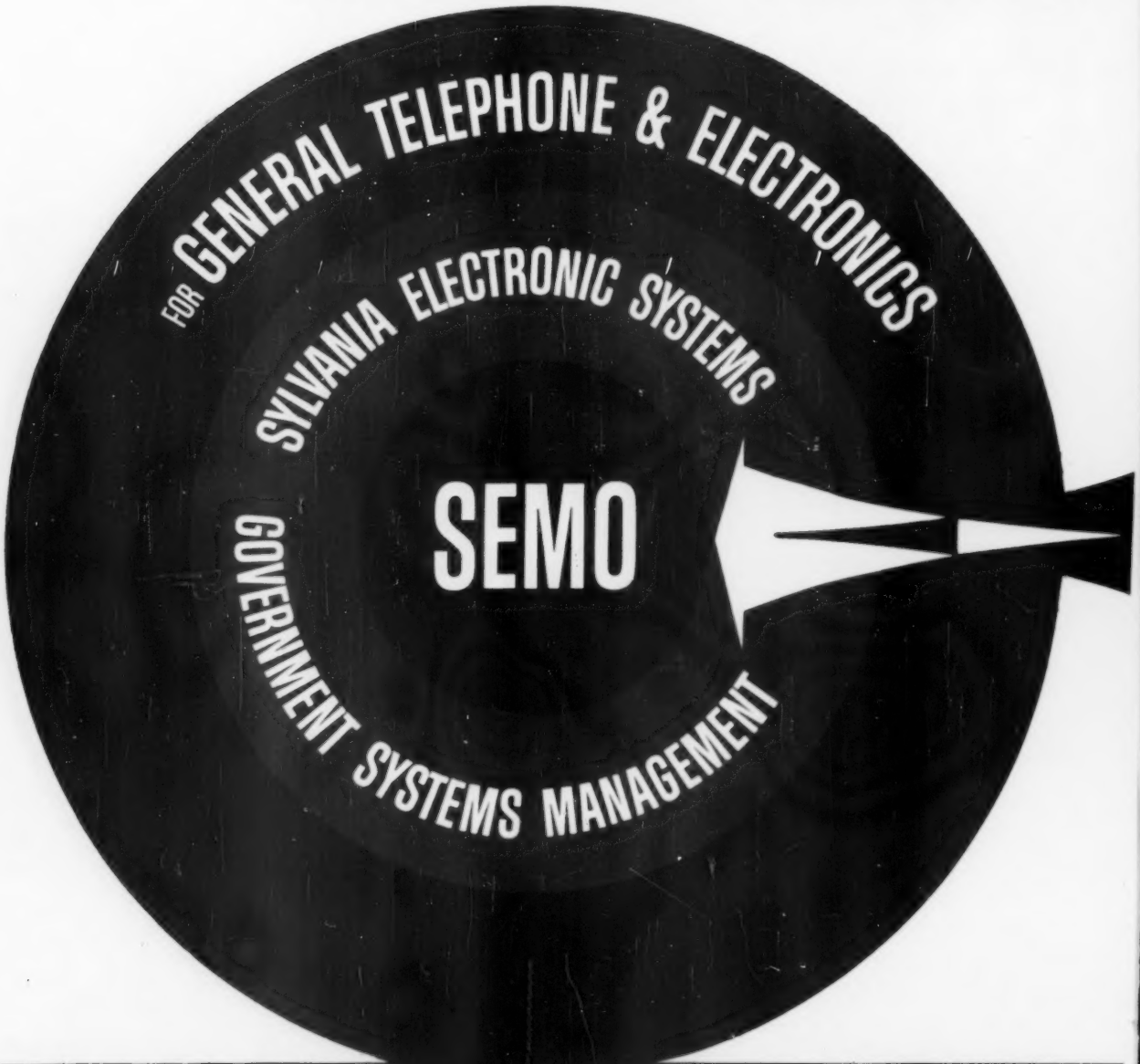

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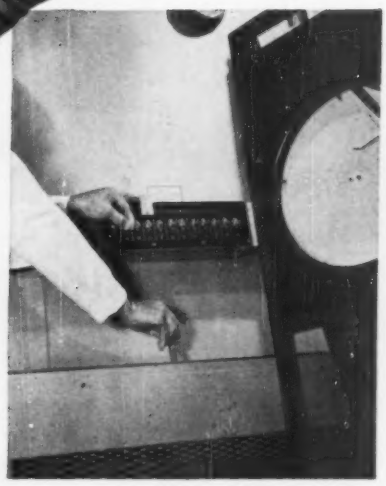

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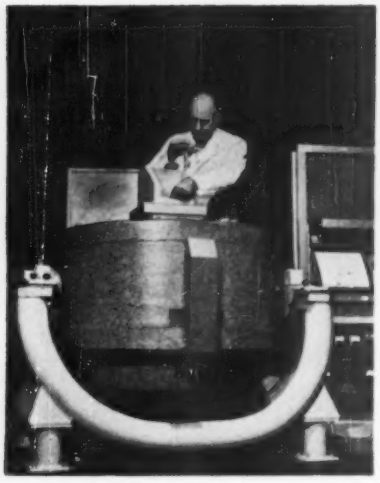

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necessary azimuth corrections. Command guidance control is handled over an AN/ARW-65 UHF radio equipped to initiate 46 major commands through 16 direct and 28 multiplexed UHF channels. Some channels are further expanded by stepping functions, a total of 66 command functions being utilized to provide guidance control for the QB-47. Flight parameters are displayed in the terminal area director through the AN/UKR-2 telemetering receiving system, which receives 12 channels of telemetered data. Availability of data through this system is increased by commutating one of the standard channels, giving 27 additional items of information which can be further expanded by stepping. A total of 18 proportional functions and 45 off-on functions are made available to ground monitoring personnel.

Airborne Control

At the takeoff field, the ground controllers transfer command of the aircraft to the overhead flying DT-33 director airplane, which flies it to a selected area, where control is transferred to another ground-based controller.

The DT-33 then breaks off to orbit the coast. Controller at this site then precisely places the QB-47 in the intercept area where the Bomarc test staff desires it for their mission, at an exact altitude, heading and airspeed.

Seconds before intercept, the scoring and countermeasures equipment is started. Scoring on the QB-47 consists of optical and electronic devices. The optical equipment comprises 12 Bell & Howell 16 mm. cameras operating at 200 frames per second, located in underwing mounted pods providing spherical coverage.

Electronic equipment is an Aerojet-General AN/USQ-7 (XI-1) system which picks up a signal source from the Bomarc by means of antenna patterns on the QB-47 wings and relays constant trajectory data from the missile to the ground station.

Scoring systems provide accurate space/time data on missile trajectory within 10 ft., with the optical system's effective range being about 1,200-1,500 ft. and the electronic system effective from about 4,000 ft.

Upon completion of the intercept, the QB-47 is routed back to Eglin's Duke Field and picked up by the DT-33, which relinquishes command to the ground controllers about four miles out from touchdown. Controller accuracy was pointed up on completion of the first QB-47 targeting mission, when the airplane was being affected by wind gusts just as the wheels were about to touch the runway and the controllers executed a successful go-around and landing.

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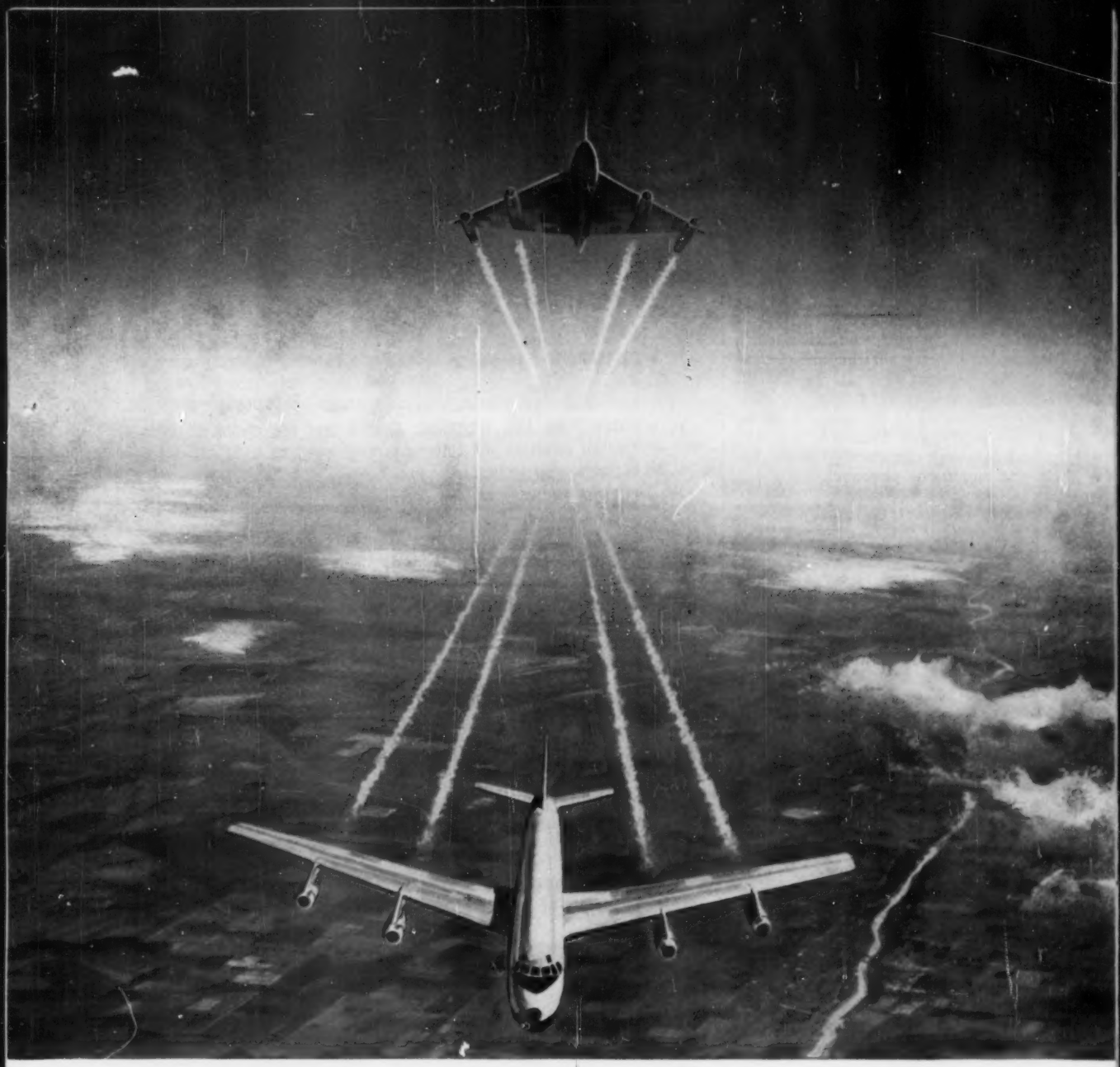

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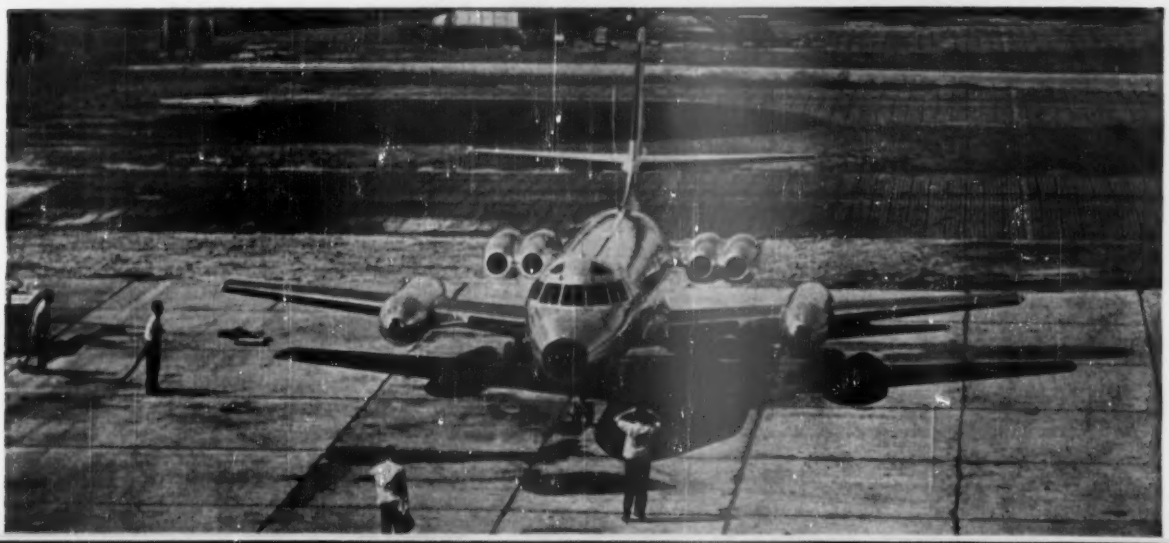
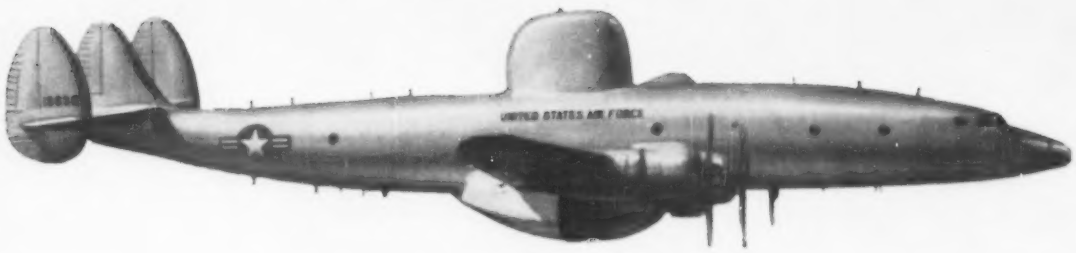
Lockheed Flies First Production Model JetStar

First production model of the Lockheed JetStar, powered by four Pratt & Whitney JT12 turbojet engines and designated C-140 by USAF, has made its first flight at Lockheed's Marietta, Ga., plant. First five aircraft will go into the FAA certification program, four in flight test and one in static. Pratt & Whitney has accepted a delivery delay in order to permit the airplane it has purchased—No. 4—go into certification testing. First aircraft to a customer will be No. 6, scheduled to go to the Continental Can Co. early in 1961 when certification is completed. Five later aircraft will go to USAF's Airways and Air Communications Service (MATS) for making inflight inspections of navigation aids. Lockheed will license three fixed base operators to cover U. S. service for the civil airplane. One will be Lockheed Aircraft Service, but the other two have not been chosen.





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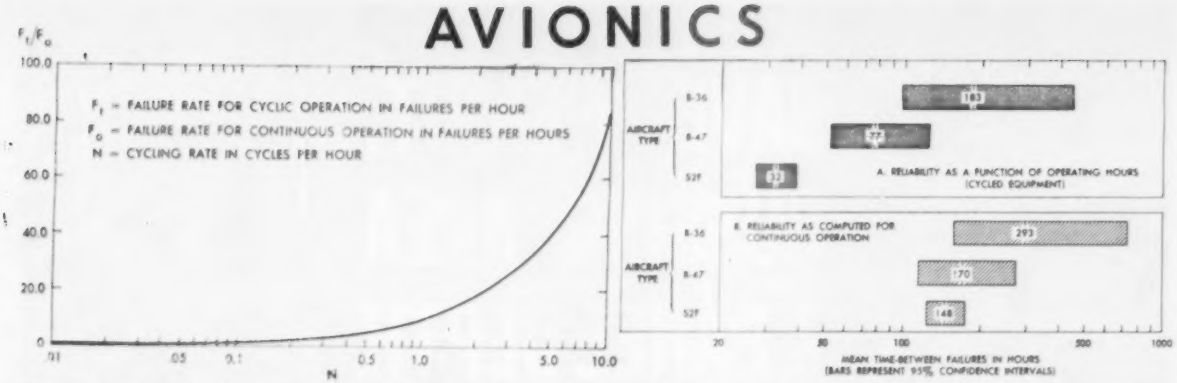

CYCLIC failure rate for electronic equipment (left) using vacuum tubes as a function of number of on-off cycles per hour, expressed as a ratio of cyclic failure rate to failure rate when equipment is operated continuously. Big variation in ARC-27 reliability (right) is experienced in different types of aircraft due to different lengths of mission (top). Variation decreases markedly when data is converted to continuous-mission basis (below).

Cycling Tests Increase Reliability Factor

By Philip J. Klass

Washington—Investigation of the effects of on-off cycling of electronic equipment on equipment reliability has disclosed results that are "startlingly opposed to popular belief and should have far reaching effects on reliability technology," according to Arinc Research Corp. which conducted the investigation.

The investigation, sponsored by Navy Bureau of Ships, sheds light on the much-debated question of whether equipment whose use is required only periodically will provide better reliability if left on continuously or if turned on only when needed.

Investigation was carried out on the USS Forrestal, using total of 163 equipments of 16 different types. Equipments were outfitted with timing clocks and counters to record both total operating time and number of times equipment was turned on and off. Some of each type of equipment were operated continuously while others were operated intermittently as needed.

Arinc Conclusions

Here are some conclusions drawn by Arinc Research Corp., based on on-off cycle rates up to 10 per 100 hr.:

• **Highest malfunction rate** occurs during first 10 min. of equipment operating cycle, running approximately 20-25% of the total malfunctions experienced. However, the malfunction rate is not as high as some proponents of continuous-operation have contended, Arinc says.

• **Contrary to expectation,** the cycling rate of equipment use does not appear to influence or induce a particular class of failure mechanism. Defects in tubes removed from highly cycled equipments were not predominantly mechanical, as had been suspected. Tubes removed from continuously operated equipments did show higher proportion of deterioration type failures than did tubes from cycled equipments, but at the expense of no-defect removals rather than mechanical failures. From this and other results, Arinc concludes that any mode of failure has two component parts, one dependent upon use time and the other dependent upon cycling. However, Arinc doubts whether it is possible to separate the two components except under highly controlled laboratory conditions.

• **Definite correlation** between cycling rate and equipment malfunctions is evidenced by data. Tests further show that cycling affects every part of the equipment, but this effect can be minimized by reducing the amount of cycling to which the equipment is subjected.

• **High degree of correlation** exists between failure rate of an equipment under continuous operation and its probability of failure per on-off cycle, i.e. cyclic failure rate. This was "totally unexpected," Arinc says.

Based on the investigation to date, Arinc Research Corp. scientists have developed a first-order approximation of the malfunction rate of an elec-

Arinc Reliability Investigation

Additional findings of significance reported by Arinc Research Corp., as result of its two-year reliability investigation aboard the USS Forrestal, include the following:

• Reduced-voltage operation of AN/SRR-13A communication receivers, using supply voltage 8% below rated value, resulted in a 2½:1 increase in mean-time-between-failure compared with sets operated at normal voltage.

• Elimination of thermal shock transient to tubes by gradual application and removal of heater voltage does not appear to have any significant effect on number of catastrophic tube failures, but it may have a definite effect on rate of tube removed due to cyclic operation of the equipment. Further tests under controlled conditions with a large sample is required to establish firm conclusions.

• NEL tube shield inserts, originally developed by Naval Electronic Laboratory to reduce tube temperature by providing better heat transfer to the tube shield, appear to have no significant effect on tube removal rate. For equipments operated with tube heat voltage continuously applied, NEL shield inserts cut tube removal rate by approximately 50%. But for equipments operated with both heater and plate power on continuously, shield inserts cut tube removal rates only by 20%, while in equipments operated intermittently, tubes operated with NEL shield inserts actually had 25% more removals. Although the inserts appear to be advantageous for certain types of tubes, in specific applications, Arinc concludes that "general use is not believed to be warranted."

• No significant difference in tube removal rates was noted between equipments operated with only heater voltage applied during periods of non-use and equipments operated with both plate and heater voltages applied continuously.

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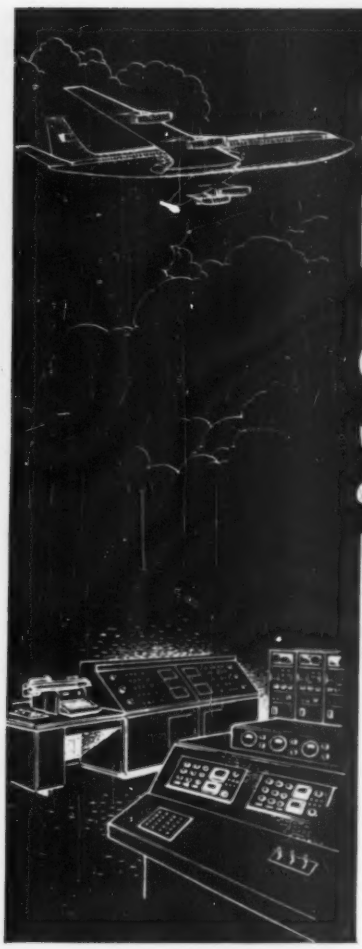

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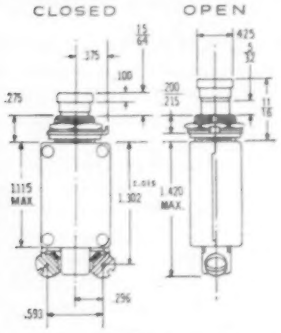

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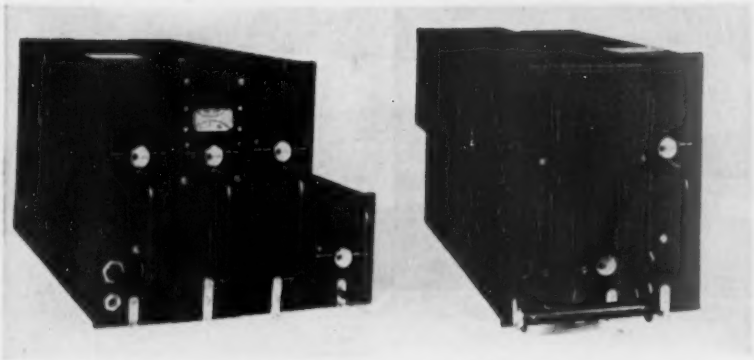

British Transistorized Navaid Equipment

New British transistorized airborne navigation and communications equipment, developed by Marconi's Wireless Telegraph Co., Ltd., will be shown at SBAC exhibition at Farnborough in September. Navigation sets, housed in short ½ ATR size cases, include (l. to r.): Type 6401 VHF omnirange receiver, Type 6402 omnirange navigation companion unit, Type 6404 glide slope receiver and Type 6403 marker beacon receiver. The VHF communications package (right) includes 25-watt transmitter, crystal-controlled, providing 360 channels (50 kc. spacing) in the 118-136 mc. band, and fully transistorized receiver providing 560 channels in the 108-136 mc. band. Total weight of transmitter and receiver package is only 23 lb. Equipment meets Arinc characteristic 520A, according to Marconi, and includes additional features such as automatic modulation control and 12 db. of speech clipping for maximum intelligibility. Company also will display new teleprinter receiver, Type AD-308, a fully transistorized unit in a short ½ ATR size case for receiving narrow-band FSK telegraph signals in the 90-150 kc. band.

tronic equipment, shown below:

$F_t = F_o + (F_c)(N)$

Where:

F_t is Total failure rate.

F_o is Failure rate for continuously operating equipment.

F_c is Failure probability per cycle.

N is the cycling rate.

Based on the finding that there is a definite correlation between continuous and cyclic operating failure rates, the ratio of F_c/F_o can be expressed as a constant. For shipboard equipments, predominantly vacuum tube units, involved in the test, Arinc has come up with a figure of 8.0 hr. per cycle for the ratio of F_c/F_o.

Using this 8.0 hr per cycle constant, the above equation can be reduced to the following expression:

$F_t = F_o (1 + 8N)$

Where

F_t is Total failures per hour.

F_o is Failures per hour of continuous operation.

N is Cycles per hour of operation.

Arinc emphasizes that further investigations will be required to confirm the validity of the foregoing expression. However, it believes that the specific constant used (8.0) should be applicable to vacuum tube equipment delivered to the military within the past five years, providing such equipment is operated at a cycling frequency in the range of approximately zero to 1.3 cycles per hour.

A curve showing the ratio of failure rate for cyclic operation to failure rate for continuous operation plotted as a function of cycling rate (see above), shows that failure ratio changes rather slowly with cycling rates below one cycle in eight operating hours (N = ⅛). At higher cycling rates, the failure ratio rises rapidly and above one cycle per hour, the cycling becomes the dominant failure mechanism.

The effect of on-off cycling may provide an important clue to partially explain discrepancies between reliability of parts and systems used in aircraft and their reliability when used on shipboard or in fixed installations, Arinc speculates.

It also may explain differences in reliability of identical equipments when used on different types of aircraft. Several years ago an Arinc reliability investigation of the AN/ARC-27 communications set disclosed that it operated for an average of 183 hr. between failure when installed on a Convair B-36, 77 hr. when installed on a Boeing B-47, and only 32 hr. between failures on a Grumman S2F. This was almost a 6:1 variation in reliability for the same equipment between the B-36 and S2F.

The average mission duration of the B-36 was 13.3 hr., that of the B-47 was 6.6 hr. and that of the S2F was only 2.2 hr. This meant that for a given total operating time, the ARC-27 aboard the S2F was turned on and off six times as often as the ARC-27 aboard the B-36.

Applying the newly developed cyclic reliability equation (above), and using the value of 8.0 as the constant, Arinc worked backward to compute what

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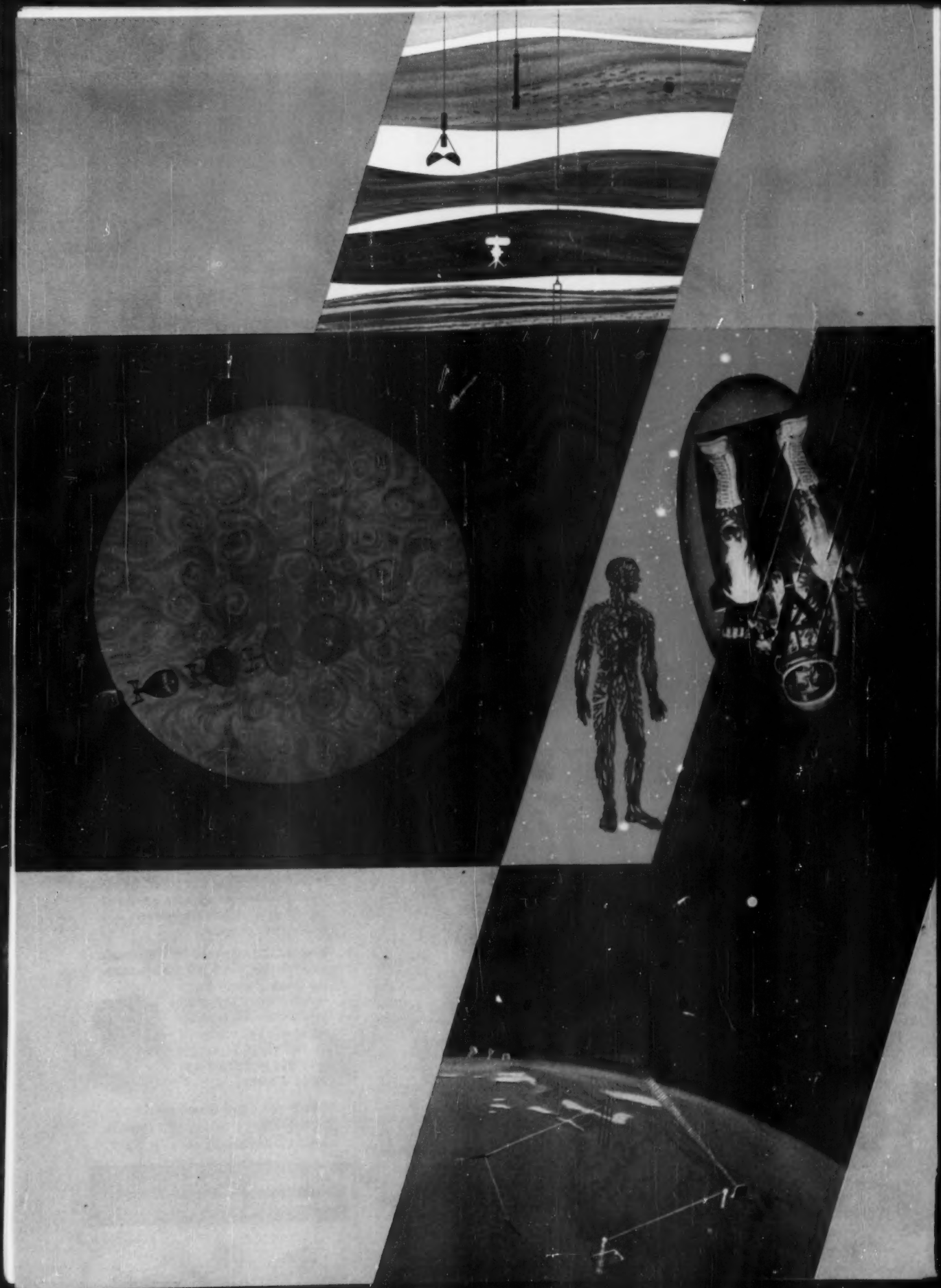

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Important staff positions at Lockheed's Research and Development Branch in Palo Alto are available. Those scientists and engineers with experience related to the above areas are invited to write to: Research and Development Staff, Dept. I-17, 962 West El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance is required.

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mean-time-between failure would have been for the ARC-27's if they all had been operated continuously, i.e. one mission of indefinite length. On this basis, the MTBF of the sets installed on the B-36's works out to 293 hr., while those on the B-47's have a MTBF of 170 hr., and those on the S2F's have a MTBF of 148 hr. On this basis, there is only a 2:1 spread. (See graph.) And if a constant with a value of 10 is used, the MTBF discrepancies between ARC-27s on different types of aircraft become less than the range of experimental error.

The results of Arinc's investigation suggest that continuous operation of electronic equipment will give the maximum reliability, in terms of total operating hours before failure. But this might result in more equipment failures per unit of calendar time than if equipment is turned on only when needed.

For example, if a given piece of equipment needs to be operated for two hours every day, but is left on continuously, the expected number of failures per day will be $(24)(F_c)$.

If, on the other hand, the equipment is turned on and operated only for the required two hours, then shut off, the expected number of failures per day will be $(2)(F_c)(1 + 8 \times \frac{1}{2})$, or $10F_c$, compared with $24F_c$ for continuous operation.

For this situation, there would be almost 2½ times as many failures per day, or per week, if equipment is operated continuously as if cyclic operation is used.

Stated in more generalized form, if the cycling factor is 8.0 (as preliminary Arinc data indicates for vacuum tube equipments), then when equipment must be operated for less than 16 hr. per day, cyclic operation appears preferable on the basis of fewer failures per day, per week, or per month. If equipment must operate for more than 16 hr. every day, fewer failures per unit time will occur if the equipment is left on continuously, Arinc's study indicates.

Arinc says it needs to establish the value of the constant (ratio of cyclic failure probability to continuous operation failure rate) for a variety of types of equipment, ranging from rotating machinery to transistorized circuits. From such data the optimum continuous cyclic operation crossover point can be determined for a variety of equipments.

Copies of the Arinc report, giving details of its investigation, may be obtained without charge by writing to Arinc Research Corp., 1700 "K" St. N. W., Washington 6, D. C., Attn: Mrs. M. C. Noble. Report is entitled: "Effects of Cycling on Reliability of Electronic Tubes and Equipments," Publication No. 101-26-160.

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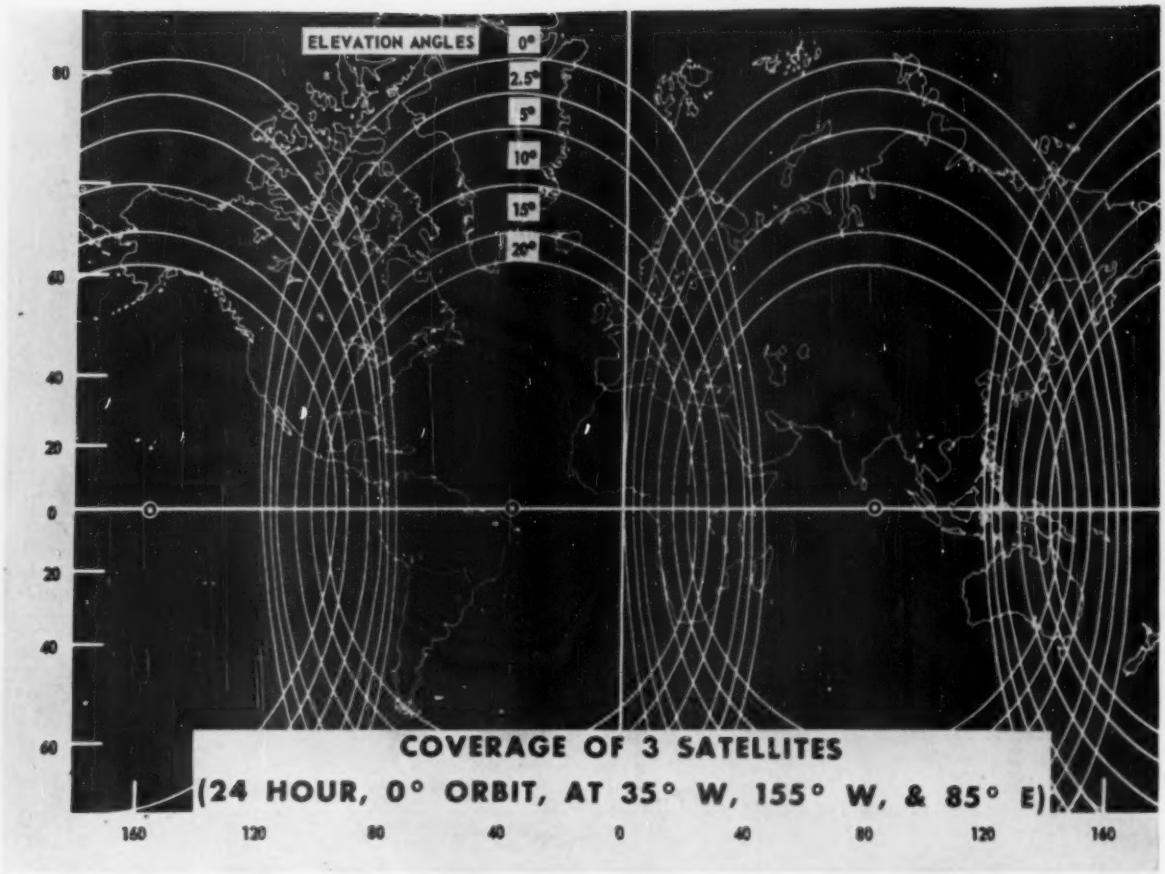


COVERAGE provided by three synchronous communications satellites in equatorial (zero inclination) 22,300 mi. high orbits is shown as a function of minimum feasible ground station antenna elevation angle relative to horizon.

Bendix Analyzes Satellite Orbit Coverage

Washington—Use of communication satellites as relays in point-to-point communications networks will add new problems to the design of network configuration because the satellite position changes with time except when a 22,300 mi. equatorial (synchronous) orbit is employed. Even synchronous orbit communication satellites will undergo shifts in position unless extremely precise station-keeping controls are provided.

An analysis of coverage obtainable with different types of communication satellite orbits, made by Bendix Corp.'s Systems Division, together with orbit confirmations which could provide coverage of areas of military and/or commercial interest, were reported here during recent Global Communications Conference by company's Charles Kent. Leonard Newland, also of Bendix Systems Division, was co-author of the paper. Bendix Systems Division has a contract to develop the Project Advent military active-repeater satellite intended for a synchronous 22,300 mi. orbit.

The coverage areas were determined by manual approximations, rather than by digital computer, but this is sufficiently accurate for preliminary system analysis, Kent told Globe-Com.

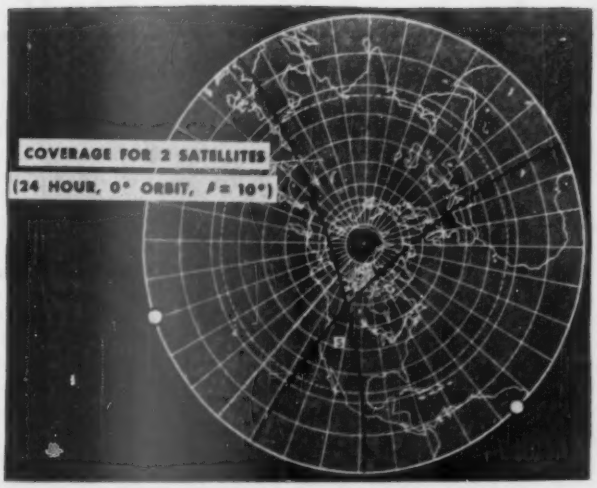
Early thinking on communication satellites suggested the use of 22,300 mi. equatorial orbits because such satellites would remain essentially fixed relative to a point on the earth, providing their orbits were highly circular.

However, such a satellite system does not provide coverage of the polar regions, an area of vital importance to the military. The upper latitude limit of coverage depends upon the minimum angle with respect to the horizon at which the ground station antenna can be operated without interference from other earth-based radio signals.

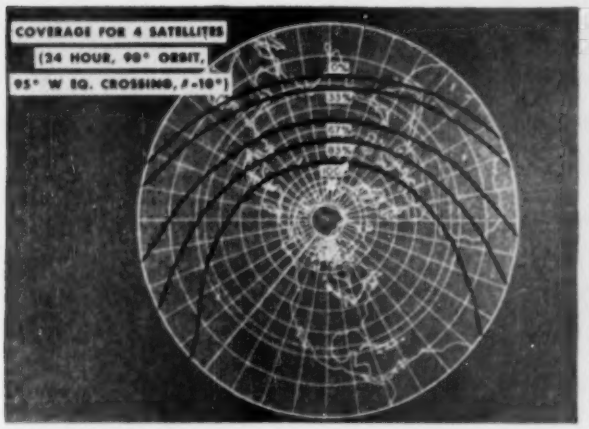
Bendix investigated the use of an inclined 22,300 mi. orbit, to provide coverage of the polar regions. Because of earth rotation, a satellite in an inclined 22,300 mi. orbit appears to an earth-based observer to be following a figure-eight path in the sky. It appears to cross the earth's equator at the same longitude every six hours, and to rise to a latitude which corresponds to its orbit inclination angle. That is, at a 60 deg. orbit inclination, satellite appears to reach a maximum earth latitude of 60 deg.

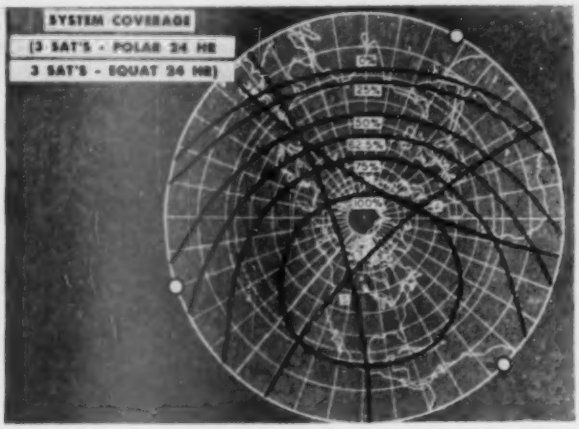
If four communication satellites are placed in an inclined 22,300 mi. orbit, separated in time by six hours, so they all traverse the same figure-eight ground track, the network can provide extensive coverage of the polar regions and much of the Soviet Union for a high percentage of any 24-hr. period. Additionally, a significant portion of the Far East and Pacific area and all of Europe and North Africa are covered 66% of the time, Kent pointed out.

A system employing three satellites in 22,300 mi. equatorial orbits, plus three in 22,300 mi. polar (90 deg. inclination) orbits, would provide truly global coverage in a manner which meets both the military and commercial needs of the United States. (See chart.) A single control center in the U. S. could be used for relaying between polar and equatorial orbit satellites. The configuration also would provide some coverage redundancy.

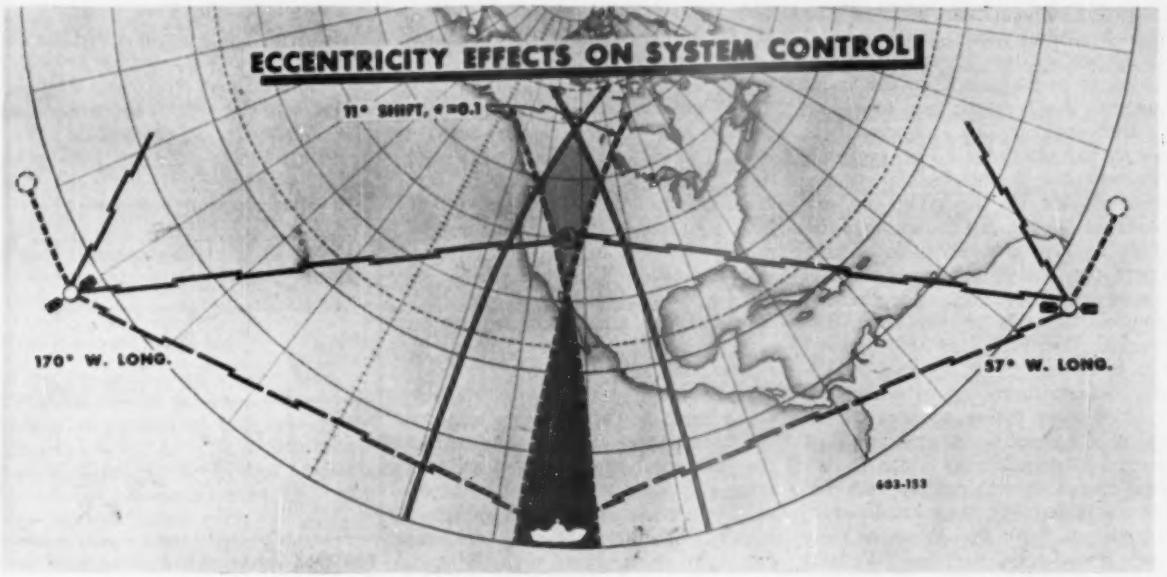


INCLINED orbit synchronous satellite circles the earth; earth-based observer sees ground track as a figure eight crossing equator every six hours. Two synchronous satellites in equatorial orbits could handle bulk of U. S. overseas commercial traffic.





CONFIGURATION giving coverage of polar regions and USSR would use four synchronous satellites in 90-deg. inclined orbit. Three synchronous satellites in equatorial orbits and three in polar orbits could provide global coverage with only two ground stations.



EFFECT OF DEVIATION of synchronous satellite from perfectly circular orbit due to initial injection error is shown above for eccentricity of 0.1, representing present state of the art. For two satellite system with single relay station intended to view both simultaneously, the 0.1 eccentricity causes an 11-deg. shift in longitude of the two satellites, moving common viewing areas from solid to dotted lines.

Industry Studies Uniform Micro Packages

By Barry Miller

Los Angeles—Representatives of major systems producers gathered here recently and agreed on a series of preferred semiconductor component formats which are expected to guide makers of microminiature avionic components during the next several years.

At the same time, the group—only last May constituted as the Subcommittee on Microminiature Components of the Electronics Industries Assn.—also adopted several proposals for non-semiconductor components regarded as the first step in bringing about uniform form factors compatible with those selected for semiconductor devices for a wide variety of future microminiature passive components. These new smaller, or micro, components are destined for use in the high-density avionic component system packaging schemes to be employed by, among others, each of the system manufacturers represented.

Some of the new smaller transistors whose commercial introduction was anticipated following the Institute of Radio Engineers convention held in New York earlier this year (AW Apr. 11, p. 94) are slated possibly for inclusion in the North American B-70 program.

It is now believed that discrete microminiature components will find extensive applications in military and space systems until such time as functional circuit and molectronic techniques take hold. System manufacturers, consequently, are anxious to encourage second sources for these interim microminiature components which are appearing in conflicting configurations not now governed by industry-wide standards.

Function of the subcommittee, according to its chairman, Ed Keonjian of American Bosch Arma, is to formulate the component package requirements of system manufacturers. The preferred semiconductor geometries and dimensions adopted by the group are not standards, but rather a consensus of the needs of system makers. In a final report, they will be submitted to Electronics Industries Assn. and other responsible agencies in the hope that standards eventually may be hammered out. In the meantime, however, component manufacturers, all of whom are excluded from voting participation on the subcommittee, are kept informed of the group's deliberations in the obvious hope that they will comply with the group's preferences in microminiature components. At the Western Electronic Show and Convention (Wescon) held here simultaneously with the EIA subcommittee meeting, two transistor manufacturers who displayed micro transistors in packages at variance with the preferred type told AVIATION WEEK that they would alter their case configurations.

Systems manufacturers represented at this meeting, third held by the subcommittee since its organization within EIA, included AC Spark Plug, Burroughs, International Business Machines, Litton, Lockheed, Martin, Philco, Radio Corp. of America, Thompson Ramo Wooldridge, Westinghouse, Autonetics, Packard Bell Electronics and American Bosch. In addition, component firms—International Resistance, Rheem Semiconductor, Philco (Semiconductor), P. R. Mallory, Texas Instruments, Cannon, and RCA (Semiconductor)—attended the meeting as non-voting participants.

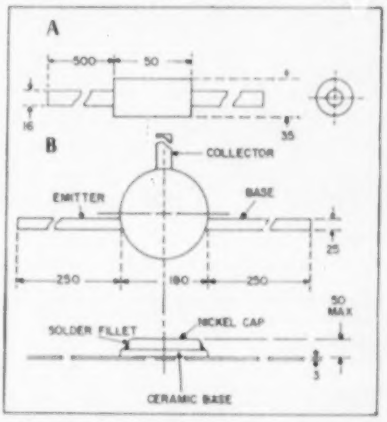
In repackaging conventional components into electrically equivalent micro components, the manufacturers are trying to boost component volumetric efficiency (ratio of volume of active element to volume occupied by component) so that more components can be packed into the small military and space systems. For many components, especially transistors, volumetric efficiency is extremely low and, should it be increased and the form of the package rearranged to shorten long dimensions and permit close packing of individual components, smaller, lighter-weight systems can be built.

An example of the poor volumetric efficiency of a conventional component was cited by Keonjian. The semiconductor wafer of one transistor case with a volume of 0.08 cu. in. accounts for only about 6 x 10^{-6} cu. in. or roughly 1/3,000 of the total component volume.

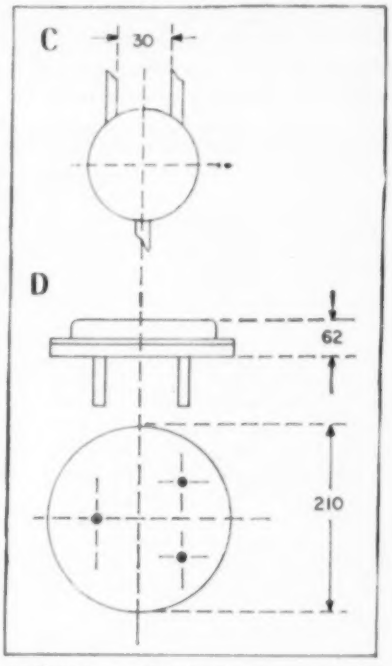
The transistor package which systems makers agreed they want should have ribbon leads coplanar to the face of the package and pointed radially outward from it as though the leads extended from the face of a clock at the 3, 6 and 9 o'clock positions. The package should be circumscribed by a cylinder, 165 mils in diameter and no more than 60 mils in height. This differs from the TO 18, the smallest industry-wide transistor package now available with its maximum dimensions of 230 mils diameter and 210 mils height.

Radial leads which are now available on a few of the newly introduced micro transistors are a departure from the traditional axial leads of electron tubes and transistors. Radial leads permit connection of the transistor in a circuit either by embedding the unit face down in the board with the leads tangent to the board face or mounted flush on a substrate, techniques now becoming common. Neither method requires bending of the leads and possible excessive stressing.

Similarly, the semiconductor diode should be no greater than 60 mils in height, should have radial ribbon leads coplanar with one side of a 90 mil diameter package. All dimensions and



VARIED PACKAGES for micro transistors and diodes in development or now offered commercially threaten to deprive systems manufacturers of alternate sources for micro components earmarked for design into high component density avionic systems. Package configurations shown are Texas Instruments' proposed micro diode (A) and its Micromesa transistor now available (B).



POSSIBLE modified lead arrangement for Texas Instruments' Micromesa transistor (C); D shows Rheem Semiconductor's diode, transistor package now available.

forms were selected by the subcommittee to be compatible with a 25 mil grid system and only after a survey of the small transistor and diode packages currently being developed by component manufacturers.

Consistent with these decisions, the subcommittee adopted an outline of the configuration it hopes all passive components with leads will meet. This included ribbon leads, one dimension perpendicular to the lead plane at a maximum of 60 mils, and leads coplanar with one surface edge of the part.

In broad terms the committee's recommendations amount to a request for a uniform configuration for all components to facilitate automatic assembly of the large numbers of them required in complex modern avionic equipment and to obtain maximum packaging densities. A few component manufacturers are now moving in the direction of uniform packaging dimensions for many types of microminiature components. P. R. Mallory, for example, recently began sampling industry interest in its pilot line production of a line of uniform dimension passive micro components, all of them leadless. The Indianapolis component firm says it has among its new micro components the following line of resistors, capacitors and a rectifier, each with identical over-all dimensions of 100 mils diameter and 60 mils in height:

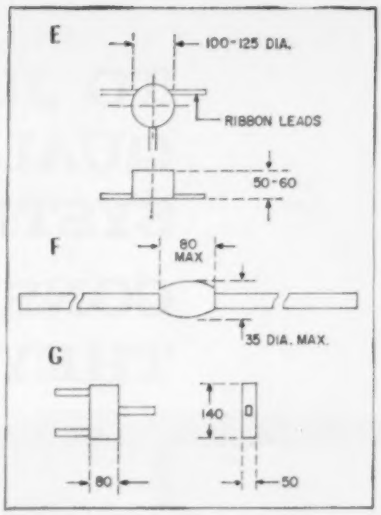
- **Carbon composition pellets** in values from 50 ohms to 5 megohms with 0.1 watt rated dissipation.
- **Metal oxide film pellets** at 250 ohms/sq. with 0.25 w. dissipation.
- **Ceramic pellets** in values up to 400 picofarads with 400 v. breakdown voltage.
- **Tantalum pellets** up to 2 microfarads with 6 v. breakdown.
- **Silicon pellets** rated at 200 milliamps and 600 v. piv.

The leadless Mallory components can be dropped into holes in a circuit board and interconnected by printed wiring or by screened-on interconnecting devices. Over-all dimensions of the components are consistent with the interests of system people as expressed at the meeting.

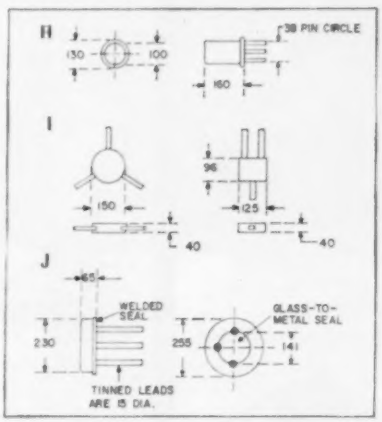
Transistors Displayed

The subcommittee's adoption of recommendations for compatible component configurations followed closely the display of a number of new micro transistor packages at Wescon. Avionic component companies that displayed new small transistors were:

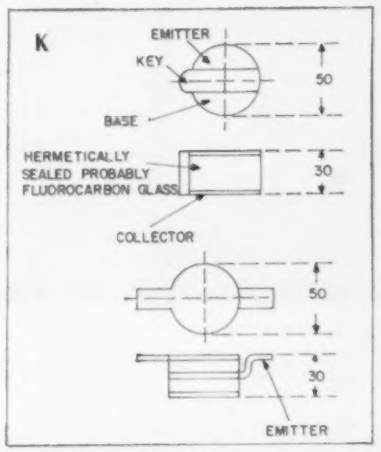
- **Transitron Electronic Corp.**—The New England firm showed developmental models of a micro transistor, which it is not yet offering for general sale. The package, 150 mils in diameter and 65 mils in height, has a ribbon collector lead with two parallel wire leads (emitter and base) which are coplanar to the device. A spokesman at the company's Wescon booth conceded that the device may experience bridging over the emitter and base leads. He added that the company will probably switch to a different package—rectangular in form with radial ribbon leads, similar to that shown in an accompanying drawing—for its commercial models due out at the end of this year. Both packages are of glass-to-metal hermetically sealed construction. With the exception of lead placement, the rectangular package fits within the form specified by the systems subcommittee. The company says it can repackage its whole line of small signal mesa transistors in the smaller package for a micro component market which it estimates as five to 10 years in duration.
- **Texas Instruments**—Two transistor types, TI 450 and 451, almost exact electrical equivalents of 2N706A and 2N753, respectively, are the first displayed units of the company's Micromesa transistor line. The circular unit, as shown in an accompanying diagram, is 180 mils (plus 10) in diameter, 50 mils in height with radial ribbon leads in the configuration preferred by the subcommittee. The package is a metallized ceramic wafer with a metal cap and can be supplied without leads for insertion in board and interconnection by silk screen conductors. Texas Instruments says its entire mesa line will be available in the small package. The TI 451 differs from its larger cousin only in that it will dissipate 450 mw. in free air at 25C contrasted with 300 mw. under like conditions for the 2N753 because of a shorter heat conduction path, according to the company.
- **Hughes Aircraft**—Developmental models of a leadless micro transistor whose commercial form will be altered slightly were displayed by Hughes. A ceramic package, the transistor will be electrically identical to larger units with the exception of smaller power dissipation. The package at Wescon is similar to the first of two early forms shown in an accompanying drawing (50 mils in diameter, 30 mils in height). Final commercial form will be egg-shaped, with the key slit to separate emitter and base, and will be 58 mils major diameter, 50 mils minor diameter. Final device, Hughes says, will have a true hermetic seal, a claim the company is now making for its developmental units. One end plate of the package will be magnetic for automatic assembly discrimination.
- **Philco**—Firm's 180 mil long, 125 mil wide, 60 mil high package was displayed but commercial units will not be available until early next year.
- **Rheem Semiconductor**—Company's metal-to-metal Microbloc transistor is



RHEEM may produce package E with radial leads. F is Pacific Semiconductor's micro diode. G is Pacific Semiconductor's surface passivated micro transistor.



RAYTHEON'S micro transistor (H) is now available. Two forms of micro transistor packages (I) are contemplated by Transitron with unit at right a more likely commercial version. Sylvania's pancake package (J) is now available.



TWO early Hughes packages.

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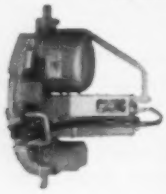

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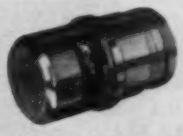

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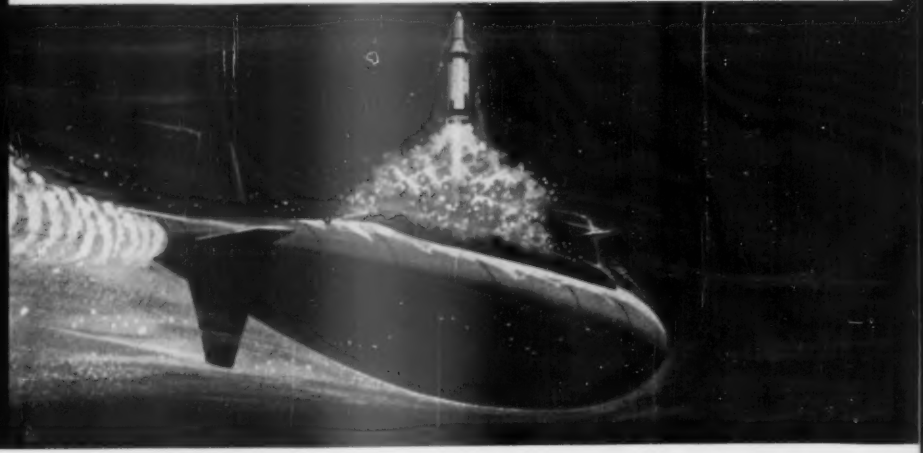

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one of two lines of micro transistors available with axial leads. Package is 211 mils in diameter (roughly the same as TO 18), 63 mils in height and is suitable for both transistors and diodes. The company says leads can be bent without excessive stressing for mounting flush atop a substrate, adding only about five mils to the height of the device. Welded hermetic seal is guaranteed for commercial units shown for the first time at Wescon. Improved electrical characteristics are claimed for the component as contrasted with its equivalent, the 2N697, particularly better power dissipation. Rheem will make radial leads for the micro transistor with the adoption of the system subcommittee recommendation, a spokesman for the firm indicated.

• **Sylvania**—Company's pancake package (AW May 9, p. 107), another of the axial lead micro transistor packages, is available in commercial quantities from Sylvania. Type SYL-1987, an npn germanium alloy switching transistor (comparable to 2N388) has ½ total power dissipation of its otherwise electrically equivalent cousin. Package is 270 mils in diameter (largest diameter of the "small" transistors) with 230 mil cap and runs to 80 mils in height (including flange).

• **Raytheon**—A 130 mil diameter all-metal welded package with a glass header is being offered by this company. Height of the unit is relatively large—160 mils.

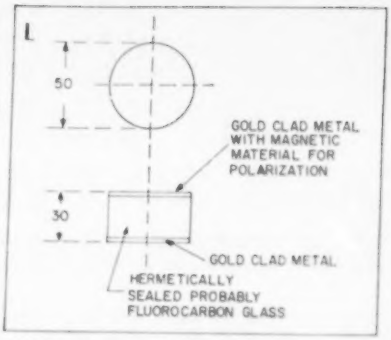
• **Pacific Semiconductor**—A pioneer in the small transistor field, this firm reports continued interest and large numbers of orders for its surface passivated micro and pico transistors since their display at this year's IRE convention. A five to 10 year market future, primarily in digital computers and secondarily in communications gear, is envisaged.

Other companies known to be developing small transistor packages including CBS Electronics and Radio Corp. of America did not display their packages.

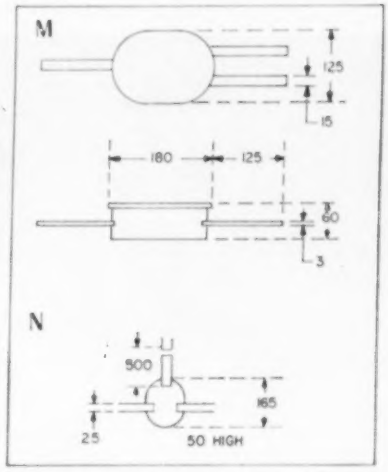
Smaller TO 18s

Besides the new micro transistors, sizable volumetric efficiency improvement can be obtained by simply reducing the size of the TO 18 package. Transitron, a company representative says, will shorten the header which shortens the seal and permits a corresponding shortening of the cap. This would cut down on the height of the package and the modified TO 18 could then be a direct replacement for the standard unit.

In evolving suitable packages for micro transistors a number of conflicting technical interests including ribbon vs. thin wire leads, axial vs. radial leads, package configuration and nature of package (surface passivated, glass-to-metal and metal-to-metal) arise.



HUGHES' micro diode (L).



PHILCO designed package M. N shows package preferred by systems manufacturers as expressed at recent Electronic Industries Assn. meeting.

The ribbon leads appear to be preferred because of difficulties encountered in welding round leads to round surfaces, because of their greater flexibility, the simplicity of a flat weld and more efficient support that is possible.

Some users report difficulties in handling the small fine-wire lead components and caution that extreme care must be exercised to avoid destroying the leads with excessive heat in circuit assembly. Ribbon leads suggested by the subcommittee should be at least ½ in. in length to assure ease of handling. These can be trimmed if necessary. The ribbons should be 3 mils in depth and 25 mils in width.

Wide Usage

Although axial lead micro transistors were developed by a number of component manufacturers for RCA's Micro Module program, radial lead components appear to be widely favored for other high density systems. Axial lead placement is regarded as a consequence of conventional projection welding. Beyond this, a market for leadless micro transistors to be inserted within the thickness of a substrate seems to be anticipated by Hughes (for the company's own system programs, at least) and Texas Instruments (which is supplying some of its Micromesa transistors without leads).

The subcommittee did not select from among the various types of cases offered by manufacturers. Any doped or coated units within the outline dimensions will be satisfactory to it, the final subcommittee report probably will indicate. Also, the subcommittee has not fixed upon any materials for semiconductor devices. The difficulty it found was that the optimum lead material choice would vary with joining method employed in circuit work.

Final report on semiconductor components embodying the preferred data adopted by the subcommittee will be prepared by its semiconductor task group. A report on non-semiconductor components will be prepared for discussion at the subcommittee's next meeting, scheduled for early November at a location as yet unselected.

The non-semiconductor task group has been asked to:

• **Establish definition** of a microminiature capacitor.

• **Report on inductors** used as pulse transformers in digital circuits.

• **Report on microminiature connector** survey considering contact and insulation resistances, capacitance losses, frequency factors up to 100 mc., dry circuit with a threshold voltage of 50 millivolts in a linear connector.

Summary of Findings

Summarizing its findings on lead materials, the subcommittee's semiconductor task group described optimum choices for each joining method. Conductive cementing will not affect selection of lead materials, it said. Gold, tin or solder coated materials would be preferred for soldering, but these are not suitable for optimum weldability. A compromise—leads of good weldable base materials and coated for good solderability—may be desirable. Where thermal compression bonding is used, gold leads are favored because of the metal's high inherent solderability and low rate of work hardening. Sealing to hard and soft glass presents another problem.

Gold leads may thus be desired for thermal compression bonding, and gold coated leads on a weldable material for solder and resistance welding, although the task group believes a further survey must be concluded to furnish data for a more conclusive report. A few subcommittee members felt the selection of materials might better be left to the discretion of individual component manufacturers.

North American's highly versatile A3J Vigilante is an all-weather aircraft with atomic fire-power capability. Chatham designed and supplies the 28VS200BL silicon power conversion equipment which furnishes the dc power. There are two units on every A3J, each delivering 200 amps.

Chatham Transformer-Rectifiers specified for NORTH AMERICAN A3J Vigilante

The North American two-place, twin-jet A3J Vigilante is an all-weather attack weapon system which can be carrier or land based. The A3J was designed to deliver a wide variety of ordnance, including nuclear weapons, at either high or low altitudes at speeds in the Mach 2 range.

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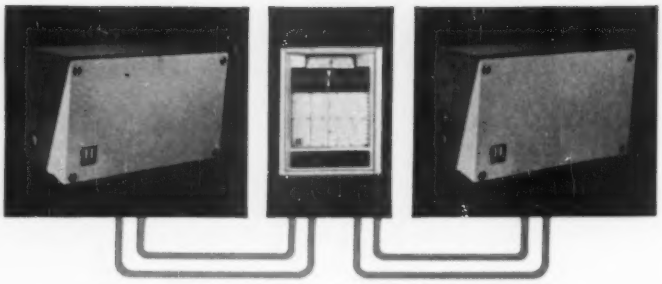

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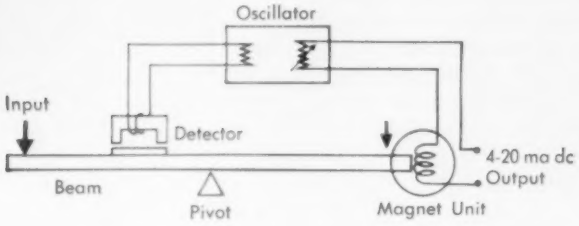

can be fed into data handling systems and millivolt-actuated instruments . . . can be easily transduced to a standard 3-15 psi pneumatic signal to operate existing pneumatic systems.

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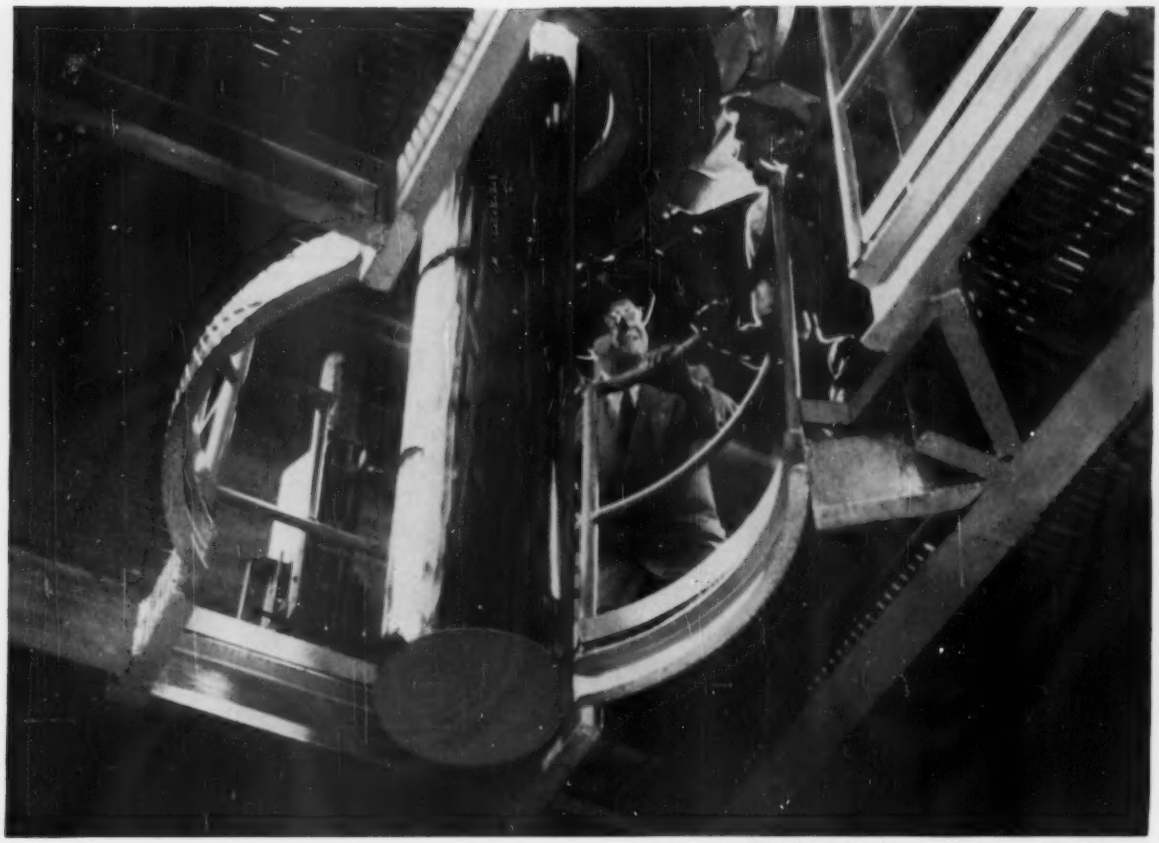

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▶ **Shoe Is On the Other Foot Now**—Airlines and aircraft manufacturers, who for many years pressed avionics manufacturers to reduce size and weight of their equipment, now find themselves facing installation and handling problems that result from drastic size reductions which avionics manufacturers have achieved, largely through transistorization. Arinc's Electronic Engineering Committee (AEEC), therefore, is sounding out airlines, aircraft and avionics manufacturers on the possibility of combined-function packaging for next-generation equipments. For example, VOR receiver, glide slope receiver and marker beacon receiver might be packaged in a single case. Another possibility is to combine VHF transmitter and receiver. The combining of several units may result in further size, weight reduction by eliminating separating tuning provisions and power supplies now built into each unit.

▶ **Transistor Reliability Reported**—British Marconi, which is introducing a line of transistorized communications and navigation equipment at this year's SBAC exhibition in Farnborough, reports that it has accumulated more than 20,000 hr. of continuous operation under temperature-cycled conditions on units without a single transistor failure.

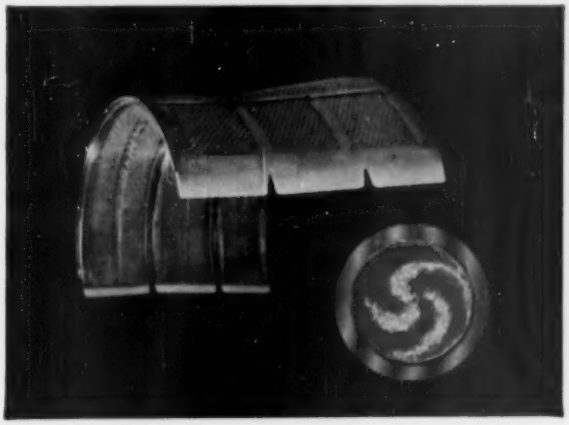
▶ **British BMEWS Poses Tough Problems**—Although Ballistic Missile Early Warning System installations in Greenland and Alaska posed difficult Arctic construction problems, the construction of a third site at Fylingdales in England is not without its own temperate-zone problems. At the insistence of The Council for the Preservation of Rural England, anxious to avoid defacing the Yorkshire countryside, the British BMEWS site will be designed so that only the three tracking radars rise above the horizon. Proposal to paint radomes brown to match the moor was rejected in favor of duck-egg blue, to blend with Britain's sky.

▶ **New Piezoelectric Materials**—Bell Telephone Laboratories scientists have discovered that zinc oxide and cadmium sulphide exhibit strong piezoelectric characteristics. When zinc oxide is doped with lithium, to neutralize its excess conductivity, the compound exhibits piezoelectricity effect that is four times as great as quartz, while cadimum sulfide is about twice as great, BTL reports.

▶ **Call for papers**—The 1961 National Symposium of the Professional Group on Microwave Theory and Techniques, scheduled for May 15-17 in Washington, is seeking papers in the field of microwave research, development and application, including solid-state microwave devices. Interested authors should send 500-word summaries, by Dec. 12, to Gustave Shapiro, National Bureau of Standards, Washington 25, D. C.

▶ **Higher Power Radar Tubes Coming**—One indication of expected growth in power levels of klystron tubes used for radar, already at peak power levels of tens of megawatts, is power supply under construction by Eitel-McCullough, major klystron producer. New facility, to be used in testing klystrons, will permit power levels 15 times greater than now required for existing tubes. Average power output of facility will be 3 million watts at 282,000 volts.

▶ **Digital Logic Meeting Papers Available**—Proceedings of the first Users' Conference on Dynamic Digital Logic, held earlier this year in Beverly Hills, Calif., now is available in a 72-page brochure which can be obtained by writing Computer Control Co., Inc., 983 Concord St., Framingham, Mass., or 2251 Barry Ave., Los Angeles 64,



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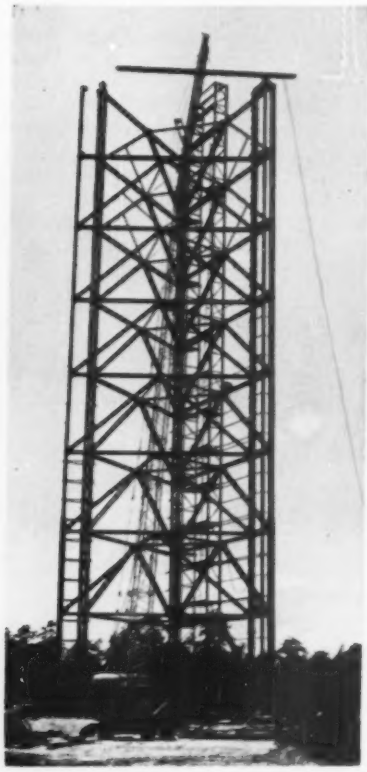
▶ **NBS Develops New Test Technique**—Method for evaluating mathematically the factors involved in variability of test results obtained by several laboratories, to distinguish between random and systematic sources of error, has been developed by John Mandel and T. W. Lashof, National Bureau of Standards in Washington. For details, write NBS Technical News Service, Washington 25, D. C., and refer to STR-2499.

▶ **New Veeps Named at RCA**—Irving Kessler and Stanley W. Cochran recently were elevated to the posts of divisional vice president and general manager for Defense Electronics Products at Radio Corp. of America. Kessler will handle the Airborne Systems Division, Cochran the Surface Communications Division.



Height-Finder Antenna

Passive height-finder radar antenna, recently installed at Federal Aviation Agency's National Aviation Facilities Experimental Center in Atlantic City, N. J., will determine height of aircraft using radar energy bounced off aircraft by conventional airport surveillance radar. Built by Maxon Corp., the system will be evaluated starting later this year. The three-sided 160-ft.-high tower supports three scanning arrays, each providing 120 deg. of azimuth coverage.

▶ **Cold-Cathode Emission**—Steady-state electron emission, on the order of 10^{-8} amperes, has been obtained from specially treated cadmium sulfide at Nuclear Corp. of America. Company's Navy Bureau of Ships supported studies (AW July 25, p. 71), of electron emission from reversed biased pn junctions designated COCAT (cold cathode), involve a search for semiconductors exhibiting large emission characteristics and the study of optimum surface conditions and junction geometry for enhancing the effects.

▶ **Signed on the dotted line**—Major contract awards recently announced by avionics manufacturers include:

• **Bell Aerosystems Co.**, Avionics Division, Buffalo, will supply digital velocity meters (integrating accelerometers) for Air Force Discoverer, Midas and Samos satellite programs under $400,000 contract from Lockheed's Missile and Space Division. Velocity meter will be used to shut off rocket engine to achieve desired orbit.

• **General Electric**, Heavy Military Electronics Dept., Syracuse, N. Y., $3.3 million contract from Rome Air Materiel Area for production of AN/FPS-7 high-power search radars for air defense use.

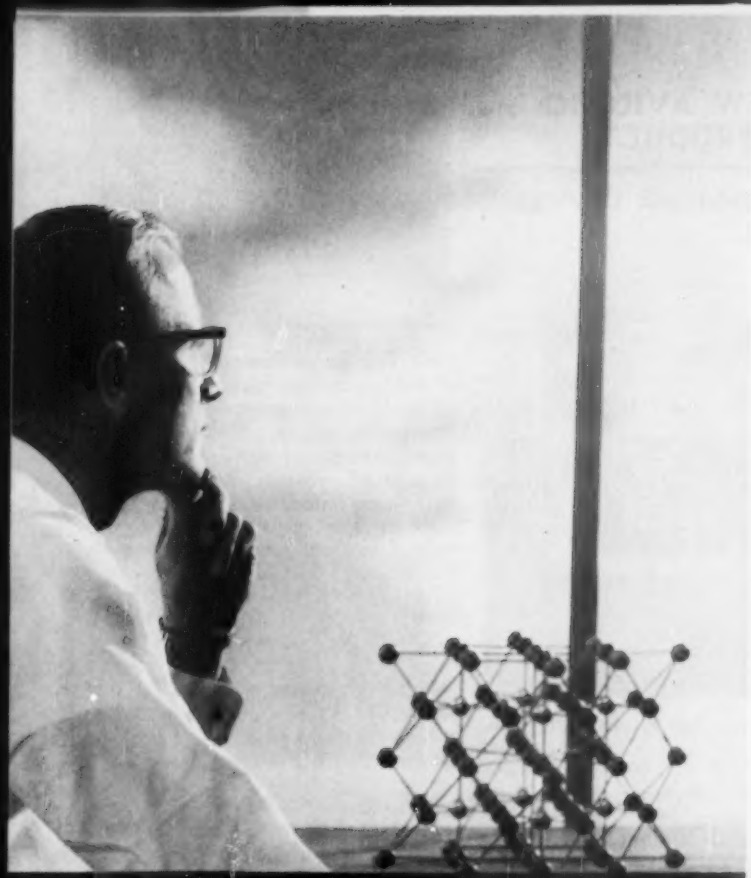
• **Sprague Electric Co.**, North Adams, Mass., $1.3 million contract for solid-tantalum, electrolytic capacitors for use in Minuteman inertial guidance system. Contract was awarded by North American's Autonetics Division.

• **International Telephone & Telegraph Corp.**, two contracts and three call orders totaling nearly $2 million from Air Force. One contract calls for ITT's Federal Electric Corp. to install SAGE time-division data link at eight USAF facilities, while another calls for installation and operational testing of a prototype model of the data link system. Three call orders provide for studies to prepare five-year forecast of wire communication needs at Air Force bases.

• **Telecomputing Corp.**, Los Angeles, will design and assemble air traffic control beacon ground systems under Federal Aviation Agency contract for $5.7 million. Systems will be installed at 36 FAA control centers throughout the country.

• **Beckman Instruments**, Systems Division, Anaheim, Calif., reports a $1.1 million contract from Lockheed's Missile and Space Division for two high-speed data processing systems for USAF's satellite programs. Systems will translate satellite data for use by variety of computers and communication systems.

• **Babcock Radio Engineering, Inc.**, $2.7 million Navy contract for production of remote control guidance systems for drone anti-submarine helicopters (DASH).



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- Solid State Developments in Materials & Devices
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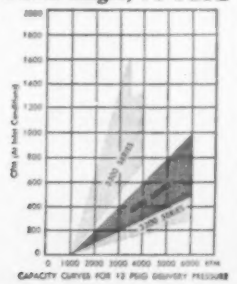

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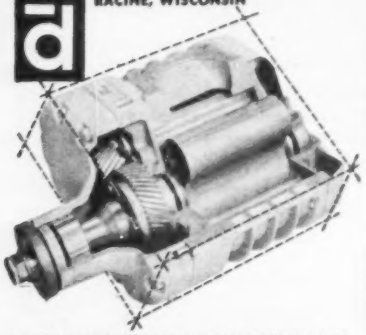

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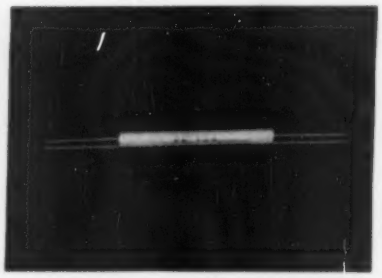
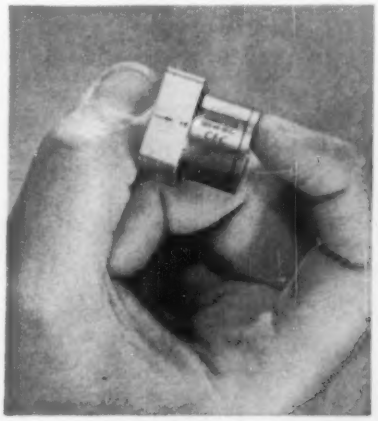


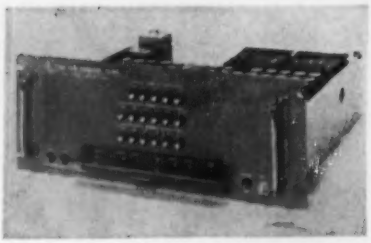
mum insertion loss. It measures 3 in. in length and ¼ in. diameter. Other units have 100 to 2,000 ohms impedance, 0.1 to 2 microsec. delay and insertion losses as low as 0.001 db. All units are rated at 500 v.d.c. test, 200 v.d.c. working and 50 v.d.c. pulse. DL-130 price is $45.50. Allen Avionics, 225 E. 2nd St., Mineola, N. Y.

• **Strain gage accelerometer,** Type 4-202, a linear unbonded strain gage bidirectional instrument weighs less than 3 oz., occupies 1 cu. in. Linearity and hysteresis rated at less than ±0.75% of full range output. Standard ranges are



from −5g to 500g. Mechanical stops permit over acceleration up to 20x rated range. Input voltage is 5 v. with full range output of 40 mv. (±20 mv.). Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

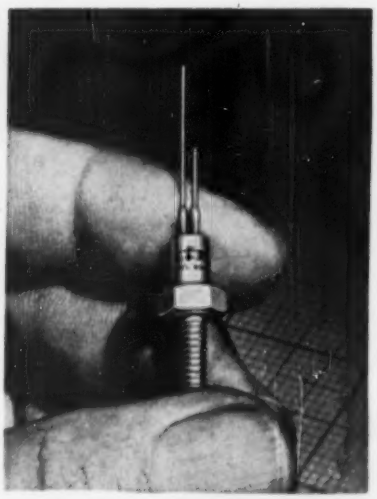
• **Time Code generator,** Model ZA-802, supplies time correlation information in Atlantic Missile Test Range or Eglin



Gulf Test Range format for laboratory or field operation. Generator provides either 17-bit memory coded time signal one per second or a slow rate 13 bit binary coded time signal every 15 seconds at a 1 pps. rate. Both codes indicate hours, minutes and seconds. Seven pulse rates are available as auxiliary signals. Frequency stability of generator is three parts in 10^9. All solid-state unit is $7,050, f.o.b. company, Electronic Engineering Co. of Calif., 1601 East Chestnut Ave., Santa Ana, Calif.

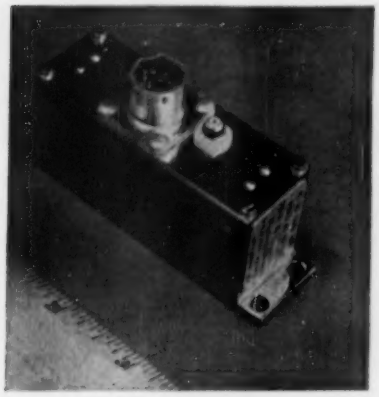
• **Trimming potentiometers,** TVR-150 series, are available in two basic lead arrangements for proper positioning on printed circuit board in missile, telemetry, radar and communications applications. TVR-153 has side-mounted pins for flat placement of trimmer on board while TVR-151 and 152 are for vertical mounting. Trimmers can be purchased in 14 ranges from 10 ohms to 100,000 ohms with 1 w. power ratings. Series meets temperature, shock and humidity mil-specs. Wells Industries Corp., 6880 Troost Ave., North Hollywood, Calif.

• **Miniature silicon controlled** rectifiers, Types X1RC2 through X1RC20, are seven units with peak inverse voltage ratings of 20, 30, 50, 70, 100, 150 and 200 v. and are capable of directly replacing mechanical relays where load currents of 1 amp. are required. Rectifiers weigh as little as 0.1 oz. All units are hermetically sealed, all welded and

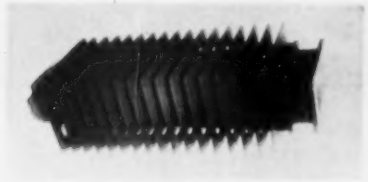


measure approximately ⅛ in. long, not including leads. Rectifiers can perform highly efficient power switching in computer, temperature control, servo, a.c. and d.c. motor control, airborne printed circuitry applications. Price range is $4.50 to $15 each in quantities of one to 99, with delivery on request. International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.

• **Amplifier,** Model 853-001 is an all-transistor a.c. signal amplifier designed to boost outputs from piezo-electric, crystal-type linear accelerometers to level required by telemetry systems. High input impedance allows use of



high-temperature high source impedance accelerometers. Gain is adjustable externally from 0.5 to 50, input impedance is 300 megohms, bandwidth is 2 cps. to 100 kc., noise is 200 v. referred to input and output impedance is 500 ohms max. Western Design Division of U. S. Industries, Inc., Goleta, Calif.



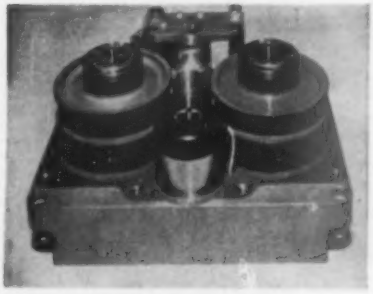
• **Dummy load,** Model 890374, for L-band radar dissipates 8 kw. of average power and 2200 kw. of peak power without liquid cooling. Load can be used used in 1.12 to 1.7 kmc. range, and measures 32⅞ in. long, 8¾ in. wide and 11⅞ in. high. It weighs 80 lb., is compatible with RG-103/U waveguide and is designed for rugged environmental conditions. Silicon carbide absorptive element minimizes water absorption, increases stability and prolongs trouble-free life. Airtron-Pacific, 5873 Rodeo Rd., Los Angeles 16, Calif.

• **Miniature wire-wound** gangable potentiometers, series 319, are ⅜ in. diameter, and less than ¼ in. high per ganged

section. Pots are available in stainless steel (servo) or aluminum (panel) versions and are gangable within a range of 100 ohms to 200 kilohms. Adjustment method positions each wiper independently throughout full 360 deg. Molded, high-temperature plastic cups with metallic details provide mechanical strength under environmental extremes. Daystrom, Inc., Pacific Division, 9320 Lincoln Blvd., Los Angeles 45, Calif.

Instruments

• **Tape recorder,** MTR-800, designed to meet shock, vibration and temperature requirements of missile environments, can record telemetry data during re-entry phases and other non-transmission periods. The recorder weighs



9 lb., measures 7⅞ in. x 5⅛ in. x 4⅛ in. and can be made to record on 7 or 14 channels at rates from 0.25 ips to 60 ips. Three hundred feet of one mil Mylar ¼ in. or 1 in. tape can be stored. Recording time is 60 sec. at 60 ips; 4 hr. at 0.25 ips. Leach Corp., 516 E. Compton Blvd., Compton, Calif.

• **VSWR monitor,** Model SMT-2, uses two calibrated crystals to generate d.c. signals proportional to the incident and reflected RF power. Monitor has 120 watt CW power capacity. Output is 50 mw. d.c. for 50 watts RF input. VSWR is less than 1.05 to 1.0 and insertion loss is less than 0.2 db. Accuracy is ±5 per cent and unit weighs less than 9 oz., has directivity greater than 25 db. Sigma Electronics Research Corp., 15735 Ambaum Blvd., Seattle 66, Wash.

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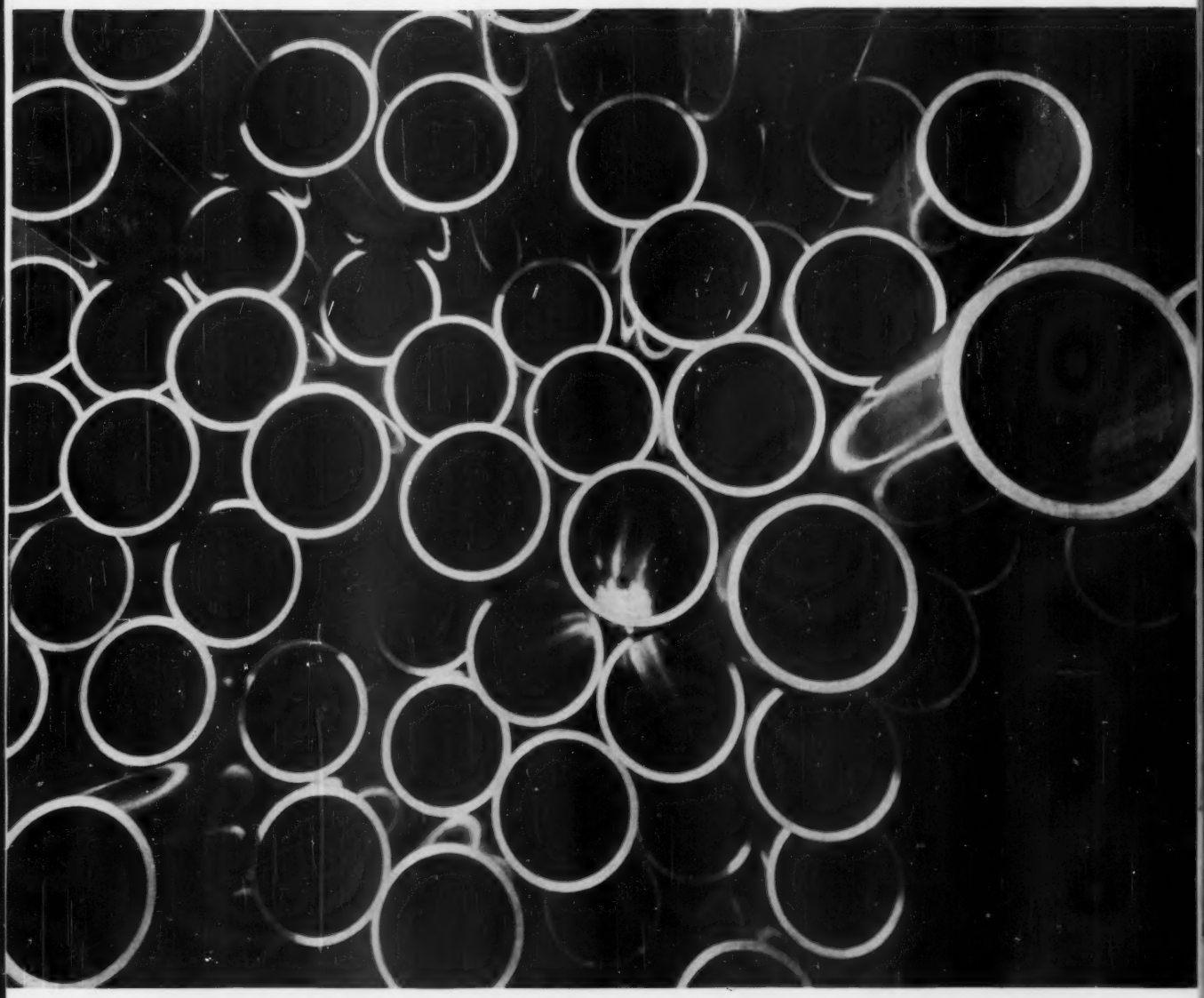

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United States Steel Supply Division
United States Steel Export Company, New York

AMC Contracts

Wright-Patterson AFB, Ohio—Following is a list of unclassified contracts for $25,000 and over as released by the Air Materiel Command:

Flight Propulsion Division, General Electric Co., Cincinnati, Ohio, J79-GE-5B turbojet aircraft engines with afterburner, Aerno 35-6109, 72 ea.; data, ground support equipment and spare parts for installations and spares for B-58A aircraft. (PR's EP-0-2840-6759; EU-0-2840-6769), $4,735,000.

Canadian Commercial Corp., Washington, D. C., handbooks for AC-IDH aircraft (quantity unknown), (MIPR 60-10-TCMAC-A and amendment 1), $154,000.

Canadian Commercial Corp., Washington, D. C., AC-IDH airplanes, (MIPR R60-TCMAC-A and amendment 2), $3 million.

Boeing Airplane Co., Wichita, Kans. B-52-14(E8-ECM) mobile training unit, 1 ea., spare parts and graphic aids, (PR SE-0-6930-3045), $250,000.

Lycoming Division, Avco Corp., Stratford, Conn., maintenance data for the T53-L-3 turboprop engine for Army AO-1 aircraft, (MIPH R59-1940-39 (NOas and amendments, 2, 3 and 4), $52,251.

Bendix Products Division, Bendix Aviation Corp., South Bend, Ind., brake assemblies, 154, 4 rotor, main (for 20.00-20 wheel), type III, FSN 1620-671-8569, Aerno 41-1201, 188 ea., wheel assemblies, main landing gear, 20-00-20 type III, FSN 1620-671-8550, Aerno 41-1200, 41 ea. for replenishment spares for C-133A and B aircraft, (PR's 00-0-1630-5786, ES-0-1630-6937 and ES-0-1630-6951), $91,500.

Western Design Division, U. S. Industries, Inc., Goleta, Calif., tutor teaching machines, contractor's model No. 723-001 with recorder and timer, 18 ea., and related data, (PR EM-0-691-6932), $83,286.

United Air Lines, Inc., Chicago, Ill., inspection, storage and maintenance services, (group B modification for FY 1960), (PR EM-0-8-6207), $30,854.

Montrose Division, Bendix Aviation Corp., South Montrose, Penna., torque pressure measuring systems, servo type in accordance with exhibit WCLCIP-289 dated Nov. 19, 1959 and amendment No. 1 dated Mar. 9, 1960 (product improvement), RFP EA-0-6658 (PR EA-O-P.I. 6658), $47,357.

Bell Helicopter Corp., Ft. Worth, Tex., increased gross weight strain gage program, H-13 helicopter, (MIPR R58-800-TCSMC-A and amendment 11), $41,832.

Westinghouse Electric Corp., Dayton, Ohio, molybdenum forgings (PR BM-O-MMP-9044), $170,155.

Olin Mathieson Chemical Corp., East Alton, Ill., cartridges, starter, aircraft engine, type MXU-4/A, FSN/1375-723-3425-M379, 36,222 ea., and data for F-105 aircraft (PR 00-0-1375-5092), $1,009,869.

The General Tire & Rubber Co., Akron, Ohio, wheel assemblies, 32x8.8, tip protection, type VIII, Aerno 41-1132, 273 ea. (replenishment spare for B-52 series aircraft), IFB 33-600-60-199(PR 00-0-1636-4907), $25,585.

Allison Division, General Motors Corp., Indianapolis, Ind., T56-A-7 turboprop engines, 32 ea., for installation in C-130B aircraft, (PR EP-0-2840-6782), $2,937,000.

The Martin Co., Orlando, Fla., GAM-83 guidance equipment for F-105D type aircraft (PR ES-0-1430-6919), $250,000.

Thomas A. Edison Industries Instrument Division, McGraw-Edison Co., West Orange, N. J., transmitters, pressure, oil, 0-50, PSI, MH-4 type, contractor's P/N 218-50A, Aerno 61-2487, 389 ea., and data for HU-1A and HU-1B and replenishment spares, RFP ES-0-6620-6735 and MA-0-05D-889(PR's EA-0-05D-889), $90,621.

Servomechanisms, Inc., Hawthorne, Calif., per cent thrust indicating systems in accordance with exhibit WCLCIP-281, revision 1 dated Nov. 24, 1959 and amendment 1 dated Mar. 1960, 4 ea., test, data and reports for service test, IFB 33-600-60-206(PR EA-8-ST-4812), $100,012.

X-Ray Department, General Electric Co., Milwaukee, Wis., spare parts for C-7 camera body, (PR MO-0-6720-12448 and amendments 1, 2, 3, and 4), $107,800.

First Photograph of Boeing B-52G Cockpit

Cockpit of a Strategic Air Command Boeing B-52G missile bomber is shown for the first time in above photograph. The intercontinental bomber carries a six-man crew, with side-by-side seating in its pressurized upper and lower decks. Production of the B-52G will be phased out at Boeing-Wichita this year as the new, longer range B-52H missile bombers begin filling the assembly lines.

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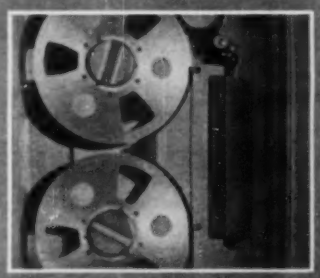

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CHANCE VOUGHT AERONAUTICS DIVISION DALLAS, TEXAS

Joint Army-Air Force Maneuvers Test Airlift, Airborne Assault

Fort Bragg, N. C.—Close planning and execution ties between Army and Air Force were evident during large scale maneuvers here in exercise Bright Star/Pine Cone III involving the largest tactical airlift and the largest participation of air reserve forces since World War II.

During the concentrated assault phase of the exercise, 7,399 troops of the Army's 101st Airborne Division were delivered—6,320 by air drop and 1,079 on the ground. Equipment delivered totaled 2,418 tons—1,244 tons by air drop and 1,174 tons on the ground.

Close cooperation between the Army and Air Force in planning the exercise was demonstrated in efficient loading of equipment and troops at nine advance bases and relatively successful delivery to assault points. Only major mishap occured during the final assault phase when 300 paratroopers of the 82nd Division drifted away from a 1,700 by 1,000 yd. drop zone due to a miscalculation of the ground wind by the drop aircraft. Compared with mass drops in the past, the exercise was relatively mishap free.

Brunt of the tactical airlift was borne by 500 obsolescent Fairchild C-119s, maintained and operated by 15 Air Force Reserve Troop Carrier Wings from bases in all parts of the U.S. Members of the reserve for the most part were performing two weeks training duty, but some were volunteers for the period of the exercise.

Supplemental Airlift

Supplementing the tactical airlift were 29 Tactical Air Command Lockheed turboprop C-130s, 30 reserve Fairchild C-123s and 50 TAC C-123s. Strategic deployment from permanent bases to advanced fields in Georgia, South Carolina and North Carolina was made by 30 Military Air Transport Service Douglas C-124s.

Scene of the assault phase was Ft. Bragg, where four landing areas from which troops friendly to the fictional country of Platka were to aid in routing invading troops from the totalitarian neighboring country of North Vada.

Tactical air support was provided by Air National Guard units flying Republic RF-84Fs and F-84Fs, North American F-100s, Lockheed F-104s, Republic F-105s, Grumman SA-16s and Martin B-57s.

Comments of senior Army officers following the mass air drops on Aug. 20 indicated that the C-130 is highly satisfactory to the Army as a combination strategic and tactical airlift aircraft. Inclusion of Army airlift requirements in design of the C-130 is evidence, they said, that cooperation has improved between the Air Force and Army in enabling the Army to deploy quickly to troubled areas where conflicts of less than all-out war size are brewing.

Army aim is to be able to move a battle group of 1,300 men a day, or a division of 13,500 a week, plus a second division including all support equipment within four weeks.

C-123 Replacement Needed

A replacement for the C-123 for operations from relatively unprepared landing areas is an urgent need, Army said. The C-130C, which incorporates boundary layer control on the wings, is considered satisfactory for the near future, but for the post-1965 time period, a more advanced design is needed.

For the intra-theater airlift requirements of this advanced aircraft, the Air Force has been told that it must be capable of carrying a 10 ton payload, have easy loading and unloading, easy field maintenance, and flight characteristics permitting operations from short, rough fields. It is up to the Air Force to determine the configuration and powerplant, Army officials said.

During the period of the exercise, an over-all figure of 95% in completed sorties was achieved. Of 782 sorties scheduled, 744 were effective

One operation at North Field, North Carolina, tested the ability of reserve crews to operate in unimproved conditions. The field has paved runways but no structures. All operations were from tents. A portable tower and ground control equipment were under a regular Air Force unit, but the remainder of the operation was manned by reserves. Elements of the 101st Airborne Division were bivouaced in forests surrounding the field awaiting the signal to board the 107 C-119s assigned.

Bright Star/Pine Cone III was the first of 11 exercises planned in both hot and cold weather areas in Fiscal 1961. The increased tempo was triggered by President Eisenhower who, in his budget message to Congress, called for an increased training effort.

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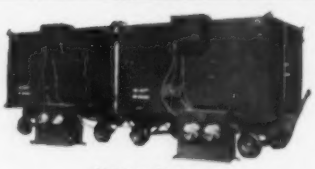

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drives heavy aircraft (to 500,000 pounds) over ice and snow when they cannot be towed by usual methods. Hydraulic cart applies power to the aircraft's wheels, making it self-propelled. The plane's own weight provides traction for safe ground handling even on wet ice. Remotely controlled by one man, on the ground or in the cockpit.

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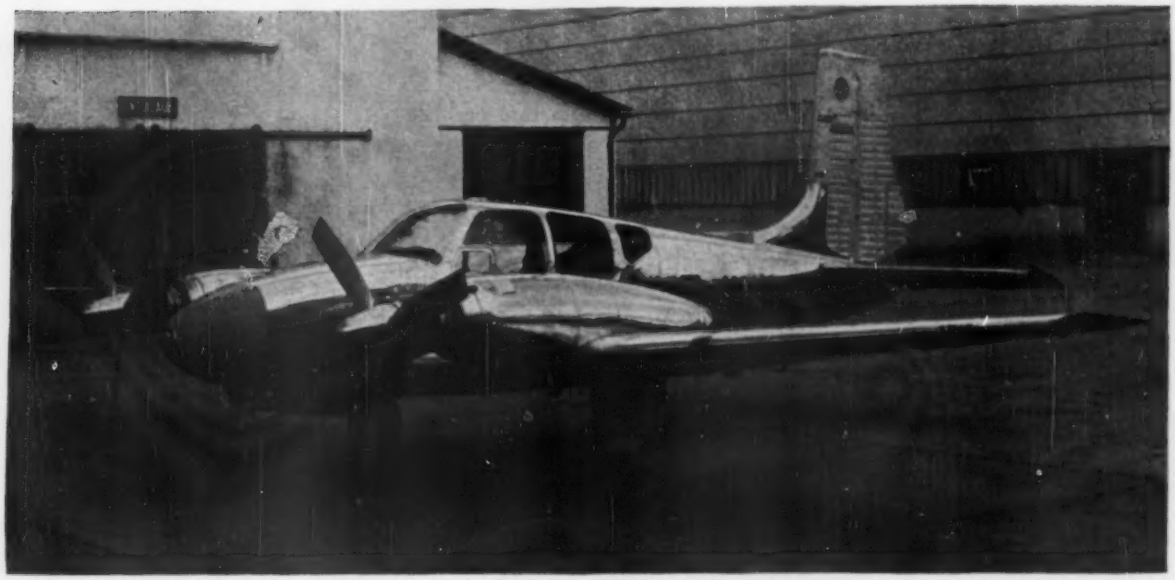


SIMILAR to the 1960 B95 version of the piston Beech Travel Air, SFERMA's 01 turbine Travel Air has a taller (about one foot), squared-off fin, curved dorsal fillet and a wider span tailplane. Plane is equipped with two Turbomeca Astazou 470 chp. turboprops.

French Developing Turboprop Travel Air

By Robert E. Farrell

Bordeaux-Merignac, France—French interests hope to move into the executive aircraft market with a Beech Travel Air retrofitted with two Turbomeca Astazou 470 chp. turboprops.

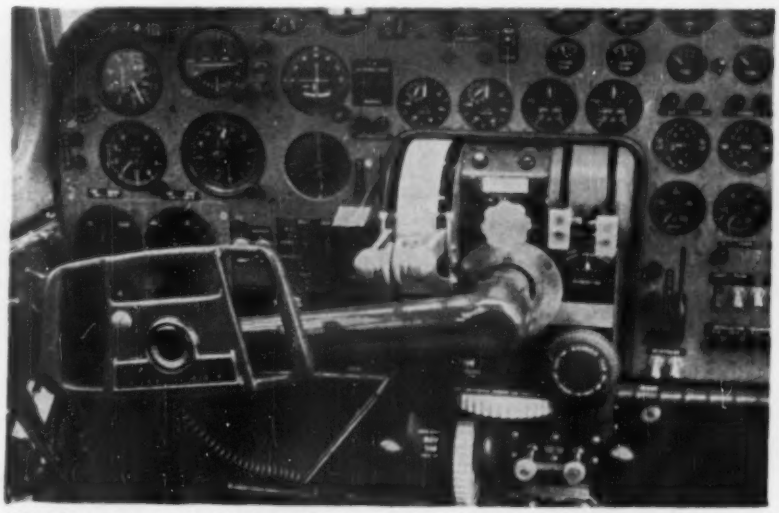
First flight of the "Turbo Travel Air" was made here on July 12. Conversion from piston to turbine power was made by La Societe Francaise d'Entretien et de Reparation de Materiel Aeronautique (SFERMA), a subsidiary of Sud Aviation. SFERMA has logged roughly 30 hr. on the –01 model. AVIATION WEEK flew on the 14th and 16th flights, carried out in the Bordeaux-Pau region.

SFERMA'S interest in the Turbo Travel Air, labeled the PD 146, is more than technical. Backed by the research and production facilities of Sud Aviation, SFERMA plans to exploit the Turbo Travel Air commercially, particularly in Europe and Africa. Beech and Turbomeca also are backing the project, mainly through technical agreements with SFERMA.

This fall SFERMA will retrofit two additional Travel Airs with Astazous. One already has been ordered from SFERMA by Joseph Szydlowski, Turbomeca president. Second probably will be bought by the French government, or SFERMA may retain ownership. In any case, all three Turbo Travel Airs will be used to accelerate the testing program now under way.

SFERMA officials are aiming at complete certification of the Turbo Travel Air by next spring. Sales campaign probably will be launched at the Paris Air Show next June, with a full-scale sales drive under way by the fall of 1961. Meanwhile, SFERMA officials this fall expect to work out final license and sales rights with Beech. SFERMA thinking is that the Turbo Travel Air, if commercially successful, will be built in France.

For the moment, SFERMA is working up a factory price between $65,000 to $70,000 for its Turbo Travel Air. This compares with a U. S. factory price of $51,500 for the piston Travel Air. These prices, of course, are before



ASTAZOU engine control system and instruments are fitted into regular Travel Air panel. Two turbine rpm. controls on right are moved completely forward as soon as engine is started, bringing turbines to constant-speed of 43,000 rpm. and prop to constant-speed of 2,400 rpm. These values remain fixed during ground run and flight. Two larger controls on the left control prop pitch and actually are only controls used to load engine. Pitch controls can be moved downward through gates into negative and reverse pitch range.

©Consolidated Diesel

equipment installation and taxes. Beech piston Travel Air in France, for example, costs about $123,505, equipped and taxes paid. Turbo Travel Air, with its French engines, won't cost much more.

SFERMA's sales pitch for its Turbo Travel Air will be based, naturally, on aircraft's higher performance with two 470 chp. Astazou turbines instead of aircraft's normal pair of Lycoming 180 hp. O-360 piston engines.

Turbo version will offer maximum sea level speed of 310 mph. compared with 209 mph. for piston version. Turbo Travel Air will climb out at 3,149 fpm. compared with 1,360 fpm. for the piston version. At a 223 mph. economic cruise, range of the Turbo Travel Air is approximately 1,100 mi.

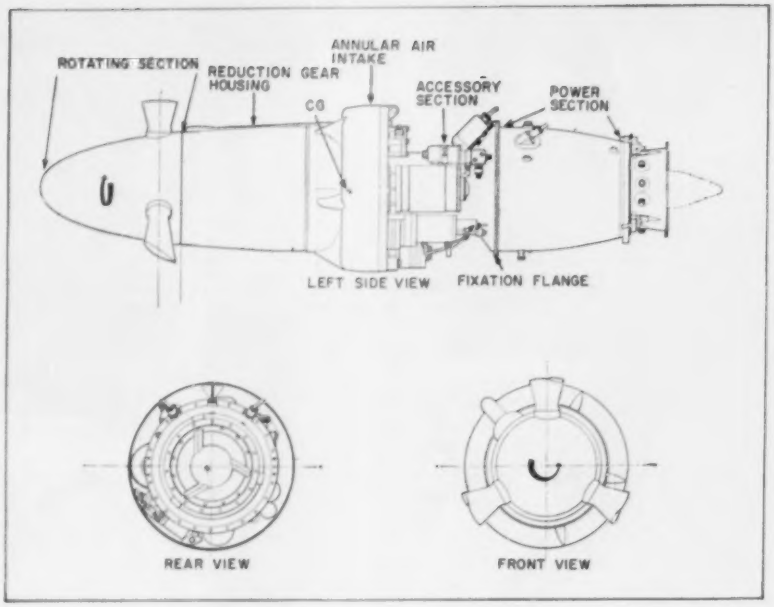
SFERMA hasn't definitely established Turbo Travel Air weights for which it will seek certification. Initial test program, however, indicates that gross weight of Turbo Travel Air will be fixed at 5,100 lb., compared with 4,000 lb. for the piston version. Empty weight of Turbo Travel Air, equipped, will be about 2,860 lb., compared with 2,570 lb. for piston aircraft. At these weights, SFERMA officials are aiming at a payload of five passengers and about 200 gal. of JP-1 fuel.

SFERMA, in addition to pushing performance advantages of its Turbo Travel Air, will also base its sales pitch on the unique control system built around the Astazou turbine by Turbomeca engineers. Unlike other turbine control systems, including those on Turbomeca's earlier turbines, the Astazou system reduces engine handling to a near push-button operation. On takeoff, in fact, maximum power is automatically achieved by simply pushing a "Max" button.

With the test program just under way, SFERMA isn't ready to quote performance or operating cost figures. Moreover, it's likely that takeoff rating of the Astazou installed in the production version of the Turbo Travel Air will be 500 chp. instead of the present certificated figure of 470 chp. In fact, some of the estimated performance figures listed in the accompanying chart (takeoff run and maximum speed, for example) are based on this higher power output.

SFERMA's Travel Air conversion project results from a long test program on the Astazou. A small turboprop was first mounted by SFERMA and Turbomeca on a Max Holste 153 for tests in the 60 to 125 mph. range. This was followed by fitting an Astazou to a Nord 1100 for speeds up to 250 mph. About 300 flight hours were logged on the Max Holste and Nord flying testbeds.

Then, in October, 1959, SFERMA decided on the Beech Travel Air as its first commercial project with the Astazou.



ASTAZOU power section includes first stage axial compressor, two rows of flow straighteners and second stage centrifugal compressor followed by two diffusers, one radial, other axial. Over-all compression ratio is 5.7/1 at takeoff rating. Annular combustion chamber has centrifugal fuel injection. Gases pass through a three-stage axial turbine and a regular section nozzle. Turbine blades and hubs are integral.

SFERMA chief engineer, Jacques Lecarme, who also doubles as chief test pilot, told AVIATION WEEK that very little structural modification was required despite the important difference in power output and performance between piston and turbine versions. Lecarme worked closely with Beech engineers throughout the modification calculations. He continues to feed test program results back to Beech in the U. S.

Configuration of the Turbo Travel Air differs only silghtly from the pis-

SFERMA Turbo Travel Air

(Preliminary Figures)

Weights

Empty weight, equipped	2,860 lb.
Gross weight	5,100 lb.

Performances

Maximum sea level speed	310 mph.
Maximum speed, at 16,500 ft	335 mph.
Economical cruising speed	223 mph.
Sea level rate of climb, two engines	3,149 fpm.
Sea level rate of climb, one engine	1,102 fpm.
Rate of climb at 10,000 ft., two engines	2,460 fpm.
Time to climb to:	
10,000 ft.	3 min. 53 sec.
20,000 ft.	8 min. 40 sec.
Takeoff distance over 50 ft. barrier	500 ft.
Landing over 50 ft. barrier	N.A.
Range, at 10,000 ft. cruising altitude, no reserves, no wind, with:	
(a) Fuel Capacity: 210 U. S. gal.	
223 mph. economical cruise	1,180 mi.
310 mph. max. speed	994 mi.
(b) Fuel Capacity: 170 U. S. gal.	
223 mph. economical cruise	932 mi.
310 mph. maximum speed	745 mi.

Winning pilot Aileen Saunders of El Cajon, Calif., right—and co-pilot June Douglas of Fall River, Mass.

AC MAKES IT FIVE STRAIGHT IN THE POWDER PUFF DERBY!

Again in 1960—AC sparked the first place winner in the annual "Powder Puff Derby"—All Women Transcontinental Air Race. This makes five firsts in as many years for AC Aircraft Spark Plugs—and the second win in a row for pilot Aileen Saunders. Mrs. Saunders flew her Cessna 172 "Cool Lady" 2709 miles from Torrance, California, to the New Castle County Airport, Delaware, in 18 hours and 27 minutes—using AC's SR-83P platinum electrode spark plugs. AC platinum electrode spark plugs burn cleaner, last longer—give full firing efficiency for maximum performance on every stroke. If you want these same benefits for your aircraft engine, take a tip from the winners and install ACs with platinum electrodes. They're the best!

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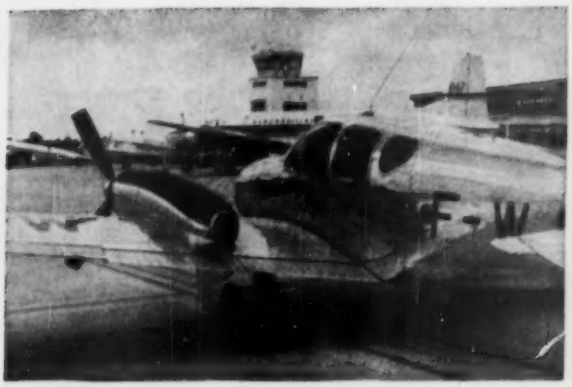
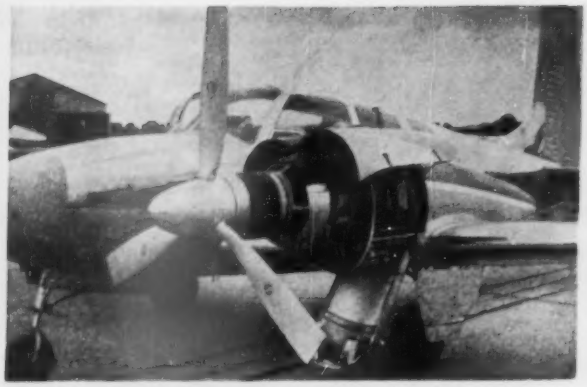
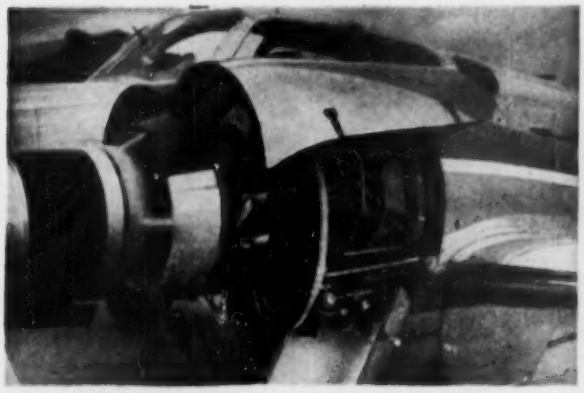
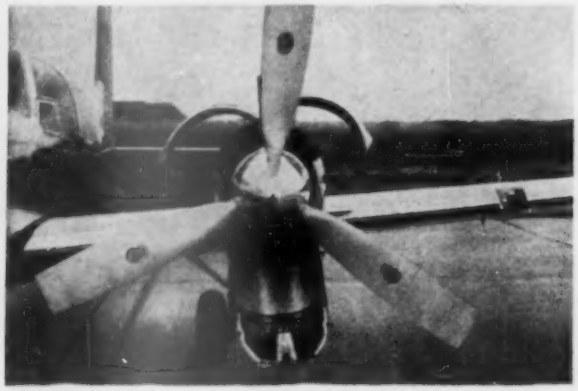




ASTAZOU is positioned about one foot farther out on wing than Lycoming engines are on piston version. Heavier type metal is used on Turbo Travel Air flaps in order to sustain vibration set up by residual thrust of 60 lb. per engine. Engine cowling arrangement is shown (right). Pitot-type measuring device located atop cowling is installed for testing program.





COLD AREA containing main accessories is shown between annular air intake and firewall, beyond which is powerplant "hot area." Secondary cold area is sealed off just below the hot area. Casing immediately in front of the annular air intake is the reduction gear casing with integral oil tank and defroster. Front view (right) may change as a result of modifications now in the works. Air scoop for oil cooling, located underneath cowling, will disappear. Future Astazous may have a larger annular air intake with special annular intake for oil cooling built into it. In order to cut down ground noise, SFERMA very likely will replace three-blade prop with four blade unit. SFERMA estimates 2.5 in. will be saved on radius, lowering noise level on ground and permitting lower pitch at cruise.

ton version. Like the 1960 B95 model of the Travel Air, SFERMA's prototype has a taller, squared-off fin, curved dorsal fillet and a wider span tailplane. Only real difference is found in the engine installation configuration.

Astazous are mounted about 1 ft. farther out on the wing than are the Lycomings, thus improving downward visibility. Jet pods and cowling are of thin stainless steel with dural blanks fitted around the exhaust tailpipe. Latter is positioned atop the wing with exhaust gases flowing over trailing edge.

Powerplant Design

Astazou is a compact power unit with total length of 5 ft. 9 in. over-all diameter of 18.1 in. and total weight of 440 lb. The engine is mounted on a welded steel tube framing. Weight given includes three-blade electric Ratier-Figeac propellers of 6.3 in. diameter. Last February, the French government certified the Astazou at a takeoff rating of 440 shaft horsepower (470 equivalent horsepower) with corresponding fuel consumption of 293 lb./hr.

Astazou control system automatically varies the engine output with airspeed changes during flight and keeps the engine at maximum power during takeoff. System consists of three basic elements:

- **Mechanical fuel governor** which keeps the turbine turning at constant speed no matter the engine load is. Constant speed setting can be varied within operating range of 40,000 to 43,000 rpm., latter representing 96.4 of maximum revolutions. On the Turbo Travel Air, constant speed is set at 43,000 rpm.
- **Temperature governor** which permits automatic loading of the engine at a given maximum tailpipe temperature as well as manual loading of the engine as long as this maximum temperature isn't exceeded.
- **Cockpit propeller pitch** controls. These are the only engine controls used to load the engine.

Engine start-up is accomplished in the usual manner with the turbines being brought up manually to the constant-speed range of 43,000 rpm. and then locked into this setting. Three-bladed propeller unit is constant speeding at 2,400 rpm. while prop pitch controls are set at zero pitch. Thus the aircraft is under no major force, despite a loud noise being made by the constant-speeding turbine and prop. Actually, each engine is exhausting some 60 lb. residual thrust which can be offset by a slightly negative prop pitch setting.

Noise Reduction

Ground noise of Turbo Travel Air should be reduced when the present three-blade prop unit is exchanged for a four-blade unit. Also, a larger air intake being designed for production Astazou should reduce noise level. For the moment, mainly to spare people at the airport here, SFERMA chief engineer-test pilot, Jacques Lecarme taxies

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out to end of runway on 80% turbine rpm. before setting the constant-speed range. Taxiing is done on residual thrust plus few degrees positive pitch.

Loading of the engine for takeoff is designed to be automatic on the Astazou. For test purposes, SFERMA test copilot, Henry Aligier carefully advanced the prop pitch levers manually during takeoff in order to maintain maximum power.

Normally, however, when ready for takeoff, the pilot simply pushes a "maximum power" button. Temperature governor, which monitors the prop pitch, then assures that prop pitch is automatically adjusted to keep tailpipe temperatures of 420C thus yielding maximum power. Cockpit prop pitch controls move up the quadrant automatically while the pilot is free from any engine control duties.

Once in the air, automatic loading of the engine is suspended when the pilot manually reduces the pitch lever to a lower setting. Specific pitch setting gives specific speed values for the aircraft. On the Travel Air, for example, cruising speed is obtained when prop pitch is set on 38 deg.

SFERMA test program will establish complete range of these correlated values as an important part of Turbo Travel Air pilot manual.

Prop Quadrant

Prop pitch quadrant presently is marked in grades (100 grades equal 90 deg.) for the test program. On the production model, the quadrant may be marked in aircraft speed values instead. Pilot thus will know exactly where to set the prop pitch lever in order to get desired level speed or desired rate of descent.

Once the pilot sets a particular pitch value, Astazou regulating system adjusts engine power to maintain demanded airspeed. If the aircraft noses down, thus increasing airspeed, mechanical fuel governor reduces fuel flow and tailpipe temperature drops as power drops. If the aircraft begins to climb, the fuel governor begins to pump more fuel into the turbine while tailpipe temperature increases along with power. The pilot hasn't touched his engine controls since initial setting of prop pitch.

Astazou self-regulating system also contains built-in safeguards against engine overloading. On automatic takeoff, for example, if for some reason the tailpipe temperature is exceeded, blade pitch is automatically reduced—down to flight fine if necessary—until the temperature limit is re-established.

During flight, the temperature governor normally won't accept any manual pitch setting which overloads the engine. If this does happen, prop pitch is automatically reduced to 12 deg.

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The other oscillator in the photo is Tele-Dynamics' time-proved Type 1250, hundreds of which have been produced for aircraft, missile, and satellite applications.

Both these lightweight, transistorized oscillators offer predictable performance, excellent thermal stability, and the ability to withstand the toughest environments. Neither requires a regulated power supply. *Both are on-the-shelf for immediate delivery.*

These oscillators are only two of a family produced by Tele-Dynamics for your specific systems needs, along with a companion transistorized wideband amplifier and mount. For detailed technical bulletins, call the American Bosch Arma sales offices in Washington, Dayton or Los Angeles. Or write to Tele-Dynamics Division, American Bosch Arma Corporation, 5000 Parkside Avenue, Philadelphia.

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Finally, if the temperature governor malfunctions, an "over-temperature" warning light goes on in the cockpit and pitch is reduced to flight fine. Feather warning light also goes on, or automatic feathering can be provided, depending on customer preference.

SFERMA officials think the Astazou control system is particularly suited for executive type aircraft. Pilot handling is reduced to a minimum as far as engine controls are concerned.

Cruise 'Button'

Moreover, Turbomeca is working up an automatic cruising "button" for the Astazou which may be available for Turbo Travel Air production models. Thus the pilot will push one button to take off, a second to obtain cruising speed.

Control system on the Astazou also makes handling of the aircraft in approach patterns considerably less demanding on the pilot than conventional piston and turbine aircraft. Reverse pitch, obviously, also makes landing runs easier to control. Actually, on AVIATION WEEK Turbo Travel Air landings, only flat pitch was used as braking device. Reverse thrust is obtained by pulling levers down through gates.

PRIVATE LINES

Agricultural Aviation Engineering Co., Santa Clara, Calif., has acquired I.C.D. Equipment Co., maker of rotating brush-type spray atomizers for aircraft and spray deposit detection paper.

Petroleum Helicopters, Inc., has ordered a Sikorsky S-62 turbine-powered helicopter to carry personnel and equipment to offshore oil rigs. S-62 was certificated for commercial use July 6.

Serv-Air, Inc., has a $4,269,696 initial contract to operate all maintenance and support phases of the Air Force pilot training school at Vance AFB, Okla.

Colonial Aircraft Corp., Sanford, Me., received an additional $100,000 contract from International Fermont Machinery Co. to supply chassis for the Air Force MD-3 ground starting unit.

Aeroflot Amphibian

Moscow—Aeroflot has asked the Soviet aviation industry to develop an economical twin-engine amphibian suitable for use in passenger service and by the fishing industry as an observation airplane. The Soviet carrier now depends on float-equipped twin-engine Li-2RP and single-engine An-2 and Yak-12 equipment for flights requiring water landings.

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- Aircraft Flight and Electronic Systems—Largest supplier of airborne centralized flight data systems; also working with other electronic controls and instruments including missile and submarine applications.
- Missile Systems—Largest supplier of accessory power units, AiResearch is also working with hydraulic, hot gas and hydrogen systems for missiles, liquid and gas cryogenic valves and controls for ground support.
- Gas Turbine Engines—World's largest producer of small gas turbine engines, with more than 9000 delivered in the 30–850 hp class. Studies include industrial and nuclear applications.

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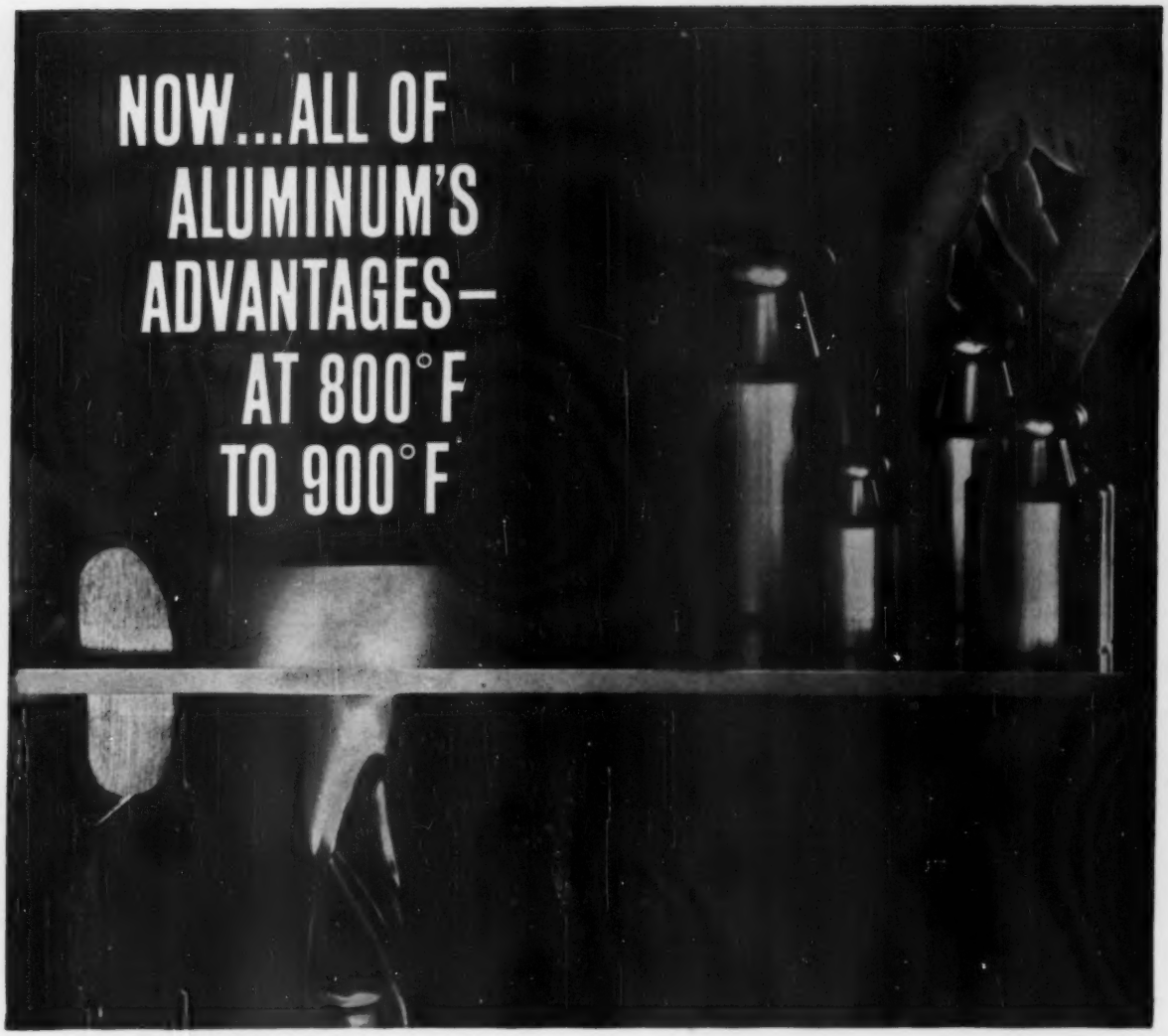

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ALUMINUM POWDER metallurgy products—"APMP" for short—are available in a family of four alloys. They are usually extruded into forms which can subsequently be further extruded, rolled, forged, drawn or impacted by conventional metal-working methods. Where you need the properties of aluminum, but where temperatures seem "too high" for conventional aluminum products, chances are that one of these four alloys may solve a host of hectic problems.

THE SUCCESSFUL development of these new APM alloys suggests what can happen when Alcoa research is applied to defense projects. We always stand ready to take on Research and Development assignments of a similar nature. For more information on APM alloys or Alcoa's R&D capabilities, write: Aluminum Company of America, 2026-J Alcoa Building, Pittsburgh 19, Pa.

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WHO'S WHERE

(Continued from page 23)

Changes

A. E. Schwerin, head of the newly organized Skybolt Re-Entry Vehicle Program office, General Electric Co.'s Missile and Space Vehicle Department, Philadelphia, Pa. Other Skybolt program appointments: **R. M. Dietz**, program engineer; **V. E. Boccelli**, project engineer-plans and schedules; **P. J. Politica**, project engineer-technical requirements; **R. G. Myers**, project engineer-design; **John Vodantis**, sales manager.

Wladimir Reichel has been named engineering counsel to all divisions of United Aircraft Corp., East Hartford, Conn.

William J. Schoenberger, northeast regional manager, Philco Corp.'s Government and Industrial Group, Wellesley, Mass.

Dr. James C. Keck, deputy director of Avco-Everett Research Laboratory, Everett, Mass.

Schuyler Kleinhans, director of advanced research, Douglas Aircraft Co.'s Engineering Department, Santa Monica, Calif., and **Charles R. Strang**, chief engineer-transport aircraft engineering.

Cmdr. Samuel A. Forter (USN, ret.), assistant director, Instrumentation Laboratory, Massachusetts Institute of Technology, Cambridge, Mass.

James C. Elms, general operations manager, Electronic Systems Operations, Aeronutronic Division of Ford Motor Co., Newport Beach, Calif.

William H. Herrman, manager of advertising and sales promotion, Electronics Division, Stromberg-Carlson, a division of General Dynamics Corp., Rochester, N. Y.

Dr. Charles E. Crompton, director of the Advanced Development Section, Isotopic Power Department, The Martin Co.'s Nuclear Division, Baltimore, Md.

Lockheed's California Division, Burbank, Calif., has announced the following appointments: **R. A. Bailey**, chief engineer-spacecraft; **W. H. Statler**, chief engineer-aircraft; **R. L. Thoren**, head of a new group as chief development engineer; **G. W. Papen**, head of a new diversification division under the chief advanced systems research engineer; **R. R. Heppe**, chief advanced systems research engineer; **James Hong**, preliminary design division engineer; **Paul W. Theriault**, aerodynamics division engineer; **J. G. Real**, chief flight test engineer.

D. R. Martin, assistant manager-purchasing and material control, Aircraft Engine Operations, Allison Division of General Motors, Indianapolis, Ind.

Donald G. Speyer, director of contracts, Bendix Systems Division, The Bendix Corp., Ann Arbor, Mich.

William Ziebell, manager of purchases, Chicago Aerial Industries, Inc., Barrington, Ill., and **Richard Masterson**, manufacturing superintendent.

H. R. Dettwyler, chief engineer, Cooper Development Division, The Marquardt Corp., Monrovia, Calif., and **Russell Loftman**, manager of advanced planning.

John Haller, purchasing agent, Aero Design and Engineering Co., Bethany, Okla.

A. T. Cavanaugh, European Technical

(Continued on page 125)

FPD PROFESSIONAL EMPLOYMENT NEWS

PUBLISHED BY THE FLIGHT PROPULSION DIVISION OF GENERAL ELECTRIC IN CINCINNATI, OHIO / SEPTEMBER, 1960

FPD NEWS offers latest information on openings throughout the Division to interested engineers and scientists. Technical information and news relating to current projects will also appear from time to time in this column.

New Lift Fan to Boost Performance and Efficiency of VTOL Aircraft

Creating propulsion systems for advanced VTOL aircraft capable of high subsonic or supersonic speed presents engineering problems that challenge the ingenuity of both the theoretician and design engineer.

With a VTOL machine, take-off thrust must exceed the vehicle gross weight with some margin, whereas only a small fraction of this power will be required for cruise. Optimizing the engine size for *both* flight regimes becomes a formidable task.

One of the concepts recently advanced by Flight Propulsion Division engineers is the lift fan illustrated in the drawing at right. Now, selection of the gas generator can be based on optimum jet-powered cruise performance.

For a given engine, fan lift is a function of fan pressure ratio and diameter. The fan provides greatly augmented thrust for the take-off mode, as verified in a recent test of a prototype configuration utilizing a G.E. J85 turbojet; the "straight-through" 2500 pounds of thrust produced by this engine was boosted to 7500 pounds for vertical flight by its lift fan.

But this is just the beginning. Developments to come will include lighter and larger fans, integrated with more powerful gas generators. We anticipate that vertical thrust/weight ratios, now about 9:1, will be elevated to 15:1 by 1965. Such propulsion systems will permit the evolvement of a new class of air vehicles for the military and, ultimately, for commercial applications.

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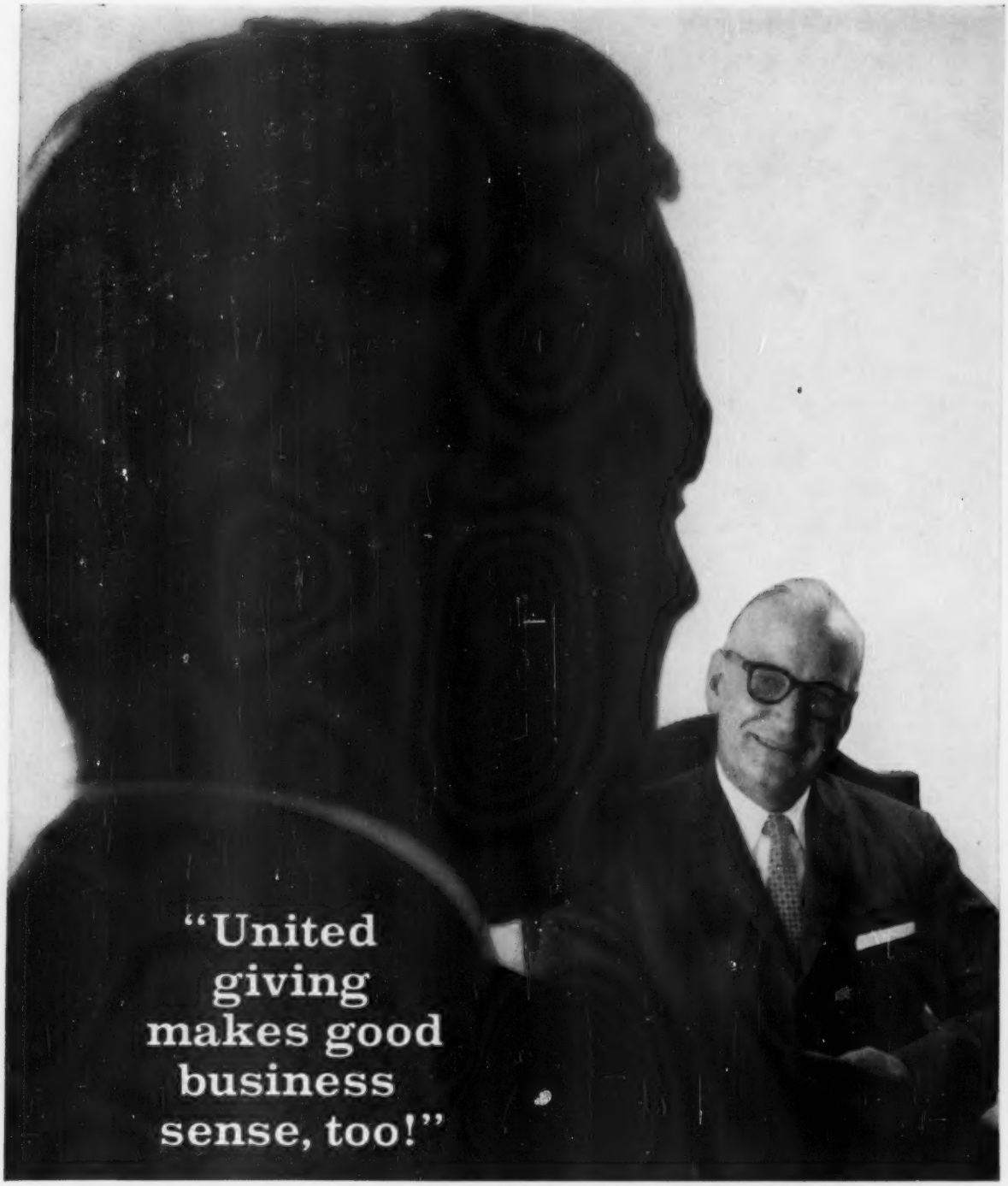

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Remember, giving The United Way helps your community *and* your company. **GIVE THE UNITED WAY**

Services Manager (Geneva, Switzerland) for General Electric Co.'s Flight Propulsion Division.

E. P. Fagan, chief-advanced systems, Military Relation Division, Ryan Aeronautical Co., San Diego, Calif.

P. C. Swan, field station manager for Douglas Aircraft Co.'s Nike Zeus missile testing operations on Kwajalein Island.

Harold J. Downes, director of international operations, Lear, Inc., Santa Monica.

Joseph E. Healy, manager of military sales, Zenith Plastics Co., Gardena, Calif., a subsidiary of Minnesota Mining and Manufacturing Co.

Dr. H. S. Sweet, manager of the newly created Aerospace Design Department in the engineering branch of Lockheed's Georgia Division, Marietta, Ga.

Francis A. Warren, senior technical specialist to the chief of Propellant Research, Rocketdyne's Solid Propulsion Operations, McGregor, Tex.

Caesar Frank Fiore, assistant director for mobilization planning, Communications Industries Division, Business and Defense Services Administration, U. S. Department of Commerce.

Francis B. McKee, product engineer, Reed Instrument Bearing Co., Los Angeles, Calif., a division of SKF Industries, Inc.

Robert L. Chapkis has joined the Aerothermodynamic Staff at National Engineering Science Co., Pasadena, Calif.

J. Paul Walsh, director of the C-E-I-R, Inc., Arlington (Va.) Research Center.

Thomas B. Riley, operations manager, National Astro Laboratories, Inc., Pasadena, Calif.

L. James Levisee, assistant to the general manager to direct and coordinate corporate diversification by external acquisitions for Hughes Aircraft Co., Culver City, Calif. **William L. Hoffman** succeeds Mr. Levisee as director of corporate materiel.

Morris Sievert, manager-turbomachinery sales, Solar Aircraft Co., San Diego, Calif.

Joseph Stolfi, manufacturing manager, Transicoil Division, Daystrom, Inc., Worcester, Pa.

Norman Wicks, director of public relations and advertising, General Precision Equipment Corp., New York, N. Y., and General Precision, Inc., a subsidiary.

Earl J. Shelton, manager of a newly established High-Power Tube Division, Eitel-McCullough, Inc., San Carlos, Calif.

F. Sutherland Macklen, director of engineering, and **Dr. M. Shaw,** manager-solid state laboratory, Ovitron Corp., Long Island City, N. Y.

British Aircraft Corp., Ltd., London, England, has announced the following appointments: **Allen H. C. Greenwood,** coordinator of aircraft sales and service; **G. R. Bryce,** chief test pilot; **R. P. Beamont,** deputy chief test pilot.

F. Robert Heyner, Bedford (Mass.) district office manager, Stromberg-Carlson Division of General Dynamics Corp.

George Walthers, manager of digital systems, Canoga Corp., Van Nuys, Calif.

Bliss M. Bushman, director of systems engineering, and **John D. Gum** and **James T. Sharpsteen,** assistant directors, Consolidated Systems Corp., Monrovia, Calif., an associate company of Allis-Chalmers, Bell & Howell, and Consolidated Electrodynamics.

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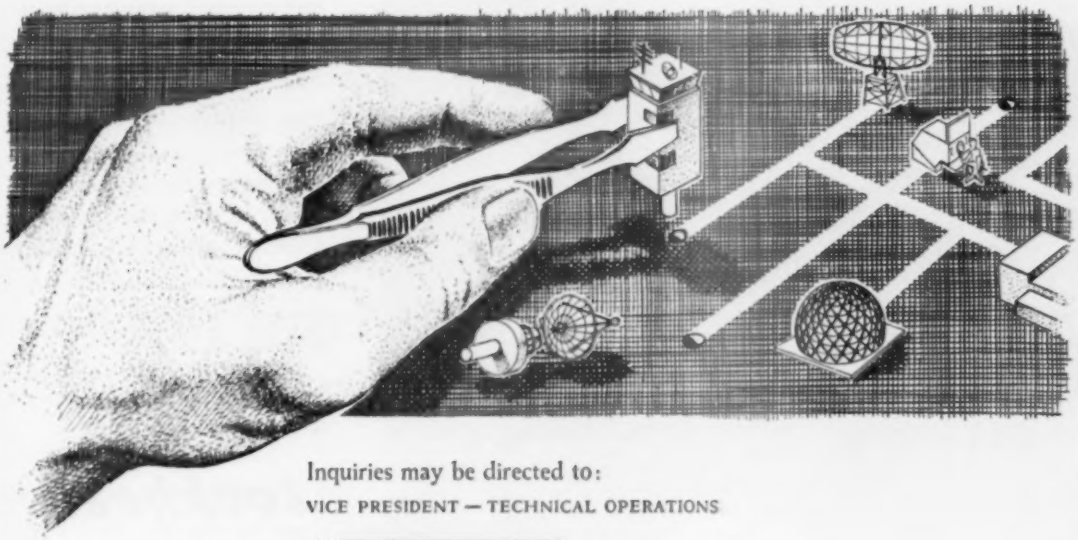

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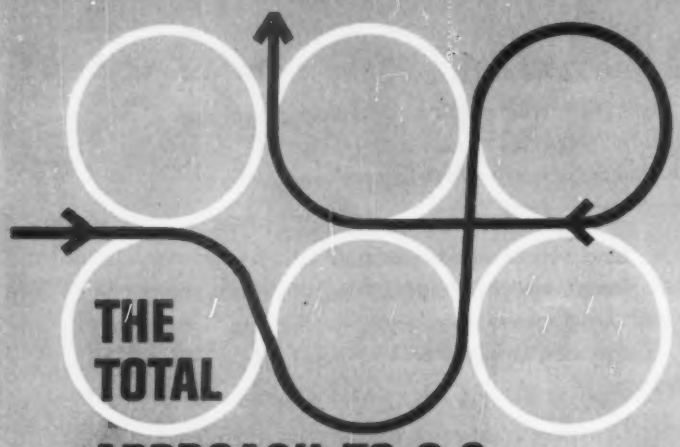

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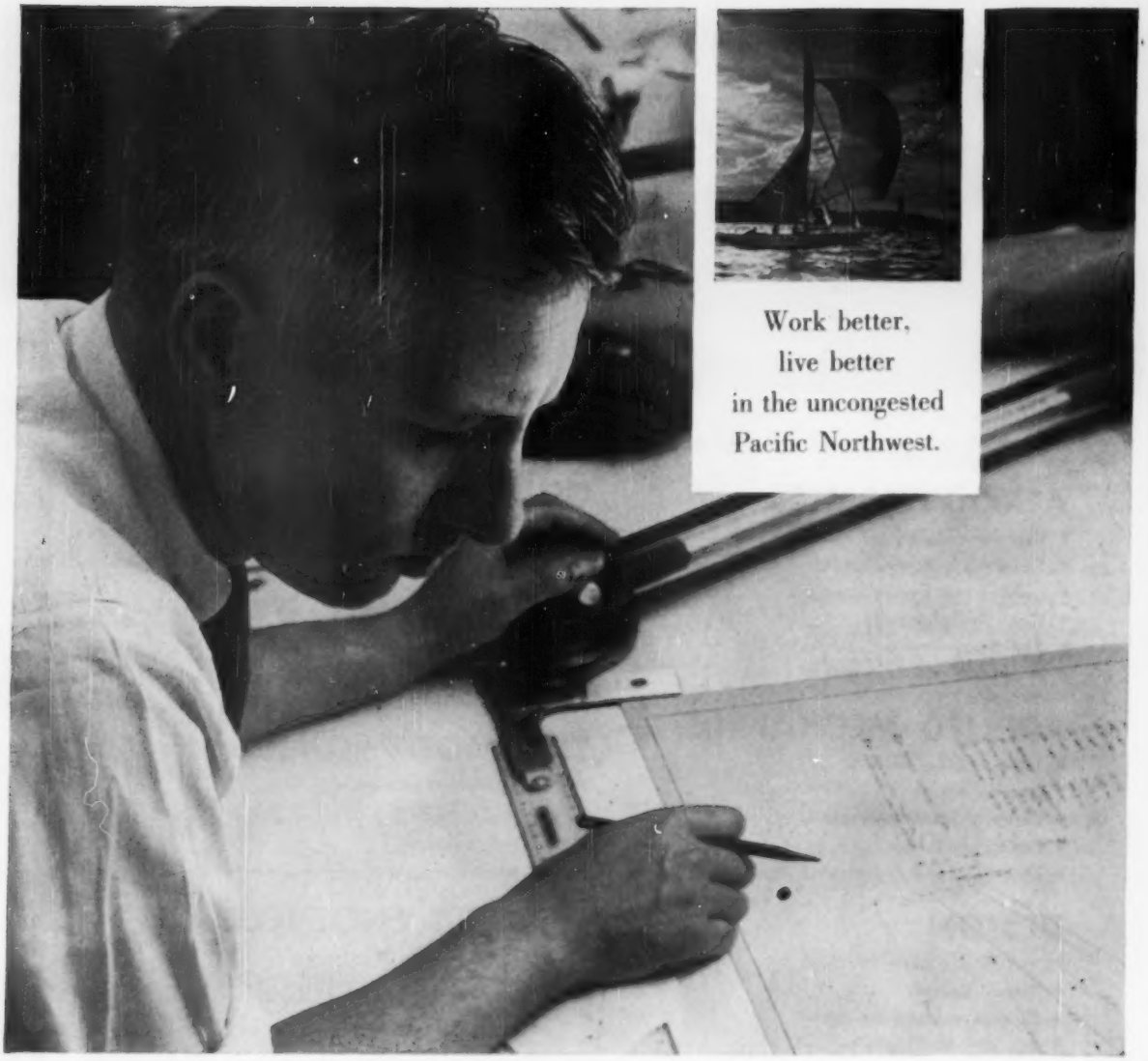

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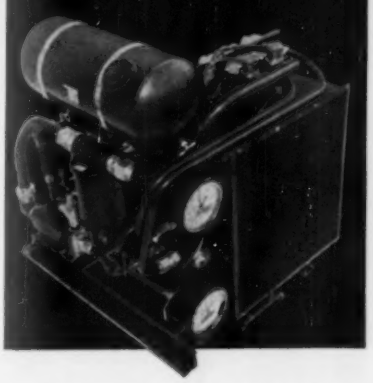

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LETTERS

ILS Concepts

I should like, if I may, to make some comments on your article, "Improved ILS System Operating at London," in AVIATION WEEK of Aug. 8 (p. 76). While not going so far as to say that some of the claims made are exaggerated, it is important to bring them into a true perspective and to point out some slight inaccuracies. As an English exchange officer working with the Federal Aviation Agency, perhaps I can do this without causing too much ill feeling.

The concept of the directional localizer was initiated by the Technical Development Center at Indianapolis in September, 1947, and perfected by them during the following seven years. The team on this project was led by Chester B. Watts, and many of the improvements to ILS can be attributed to him and his associates. Linear arrays of dipoles were familiar enough 10 years ago, but the really giant stride made at this time was the realization that by slightly offsetting the frequencies in the directional and omni arrays, the best of both worlds could be attained. That is, the high gain array would provide a beam free of course bends and the omnidirectional array would give navigational information at all other bearings round the station. By displacing the frequencies of these two radiations by some 10 kc/s there is no question of channel changing and a pilot flying his ILS indications is quite unaware of the transition from the "coarse" system to the "fine" one. This ILS, known as the MRN-7/8 is now used extensively by USAF, one of its attractions being that it is transportable.

However, TDC was not completely satisfied with the linear dipole array for two main reasons. The array had an aperture of 88 ft. and this entailed coaxial feeders some 50 ft. in length, originating from a central distribution box. Both the amplitude and phase of the currents in these feeders are critical and while the stability of coaxial lines is well understood, an array with an even larger aperture would become excessively elaborate, for it had by now been appreciated by TDC that 88 ft. was by no means the optimum aperture. The second reason for dissatisfaction is inherent in the use of dipoles. This type of antenna only radiates a truly linear field in two planes, and outside these planes an unwanted component appears. This phenomenon gives rise to "course pushing" or "attitude effect" and exhibits itself as an apparent course shift as the approaching aircraft banks. While this is not serious for an ILS approach it could become critical in an ILS landing. A parabolic aerial, which overcomes the coaxial problem, was next investigated by TDC but was found to be even more prone to course pushing than the linear array.

As a result of the realization of these limitations in the dipole and parabolic array, TDC took another forward stride. For years radar had used wave guide arrays where real precision and stability were essential, so why not apply these principles to 110 mc/s? At this frequency the smallest usable guide has a cross section about 3 ft. by 6 ft., but undeterred by the magnitude of the task, TDC developed and perfected what is known as the slotted wave guide array and during the years following 1950 built these arrays with apertures ranging from 100 to 200 ft. Nor is there any reason to suppose that 200 ft. represents the limit. The stability of the beam had now become that of the mechanical rigidity of the guide, feeders were almost entirely done away with, and the slot antennas had eliminated course pushing since this kind of antenna does radiate a truly linearly polarized field.

Unfortunately, it is still a far cry to suppose that these improved ILS Systems are suitable for automatic landing, which your article rather naively suggests. While a straight course is mandatory for this operation, other requirements are equally important. On either side of the course the deflections must bear a known relationship to the distance of course, and furthermore, the rate of change of these deflections with departure from the center line must behave in an orderly manner. Nor is it only the stability of the ground equipment which must be considered. The airborne receiver has an equal part to play.

At this time it is only the leader cable system which is known to provide these essentials to the required degree of accuracy, and for these reasons, the FAA is planning a careful experimental comparison between leader cables and the wave guide localizer for azimuth guidance in all-weather landing.

It should also be pointed out that possibly the greatest limitation to the use of improved ILS for landing is that produced by the overflying aircraft—a defect from which the leader cables are immune. None of these ILS aerial systems limits the radiation significantly in the vertical plane, (although the wave guide array is superior to the dipole array in this respect), and consequently an aircraft even at 10,000 ft. over the aerodrome may under some circumstances reflect sufficient energy to distort and temporarily destroy the ILS beam.

During the critical phase on an automatic landing, i.e. from 100 ft. altitude onwards, such interference with the azimuth guidance would be disastrous. While there are ways of minimizing this effect, the only sure one would seem to be by prohibiting other aircraft the use of the critical airspace.

Finally, one last remark on the STAN 8 glide path. In your diagram of the radiation patterns of this glide path array you show two narrow beams overlapping at 3 deg.

If this is really so and the aerials shown do produce this configuration, all electronic engineers will be avid for more details.

Or is it possible that some of the poetic license in your article has also crept into your illustrations?

A. N. BERESFORD
Federal Aviation Agency
Bureau of Research and Development
National Aviation Facilities Experimental Center
Atlantic City, N. J.

(The fact that FAA is planning tests to compare utility of leader cable system and the wave guide localizer for azimuth guidance in all-weather landing, as Mr. Beresford reports, would appear to belie his earlier statement that it is "a far cry to suppose that these improved ILS systems are suitable for automatic landing." One major disadvantage of the leader cable system for azimuth guidance in the final approach is the fact that it requires an additional piece of equipment aboard the aircraft and the acquisition of additional real estate in many airport locations. Where approach to instrument runway is over water, problem and cost of installing leader cable is increased. —ED.)

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Lift-Fan Engine

Please extend our congratulations to your engineering editor, J. S. Butz, Jr., for his excellent article, "Lift-Fan Engine Shows VTOL Potential" (AW Aug. 8, p. 94). Mr. Butz's discussion of our General Electric system and our belief that this system will make an important contribution to future aviation was accurate and complete.

You should know that the article interested other than ourselves in the Flight Laboratory Department. Our VTOL hardware exhibit at the Association of the U.S. Army Convention, held shortly after the article appeared, attracted many persons who first learned of the system through Mr. Butz and your publication.

The kind of reporting Mr. Butz accomplished on our VTOL system deserves not only a salute from us, but establishes the requirement to say for the record that it is just such reporting which makes AVIATION WEEK the recognized leader in its field.

We are delighted to do both.

A. P. ADAMSON, Manager
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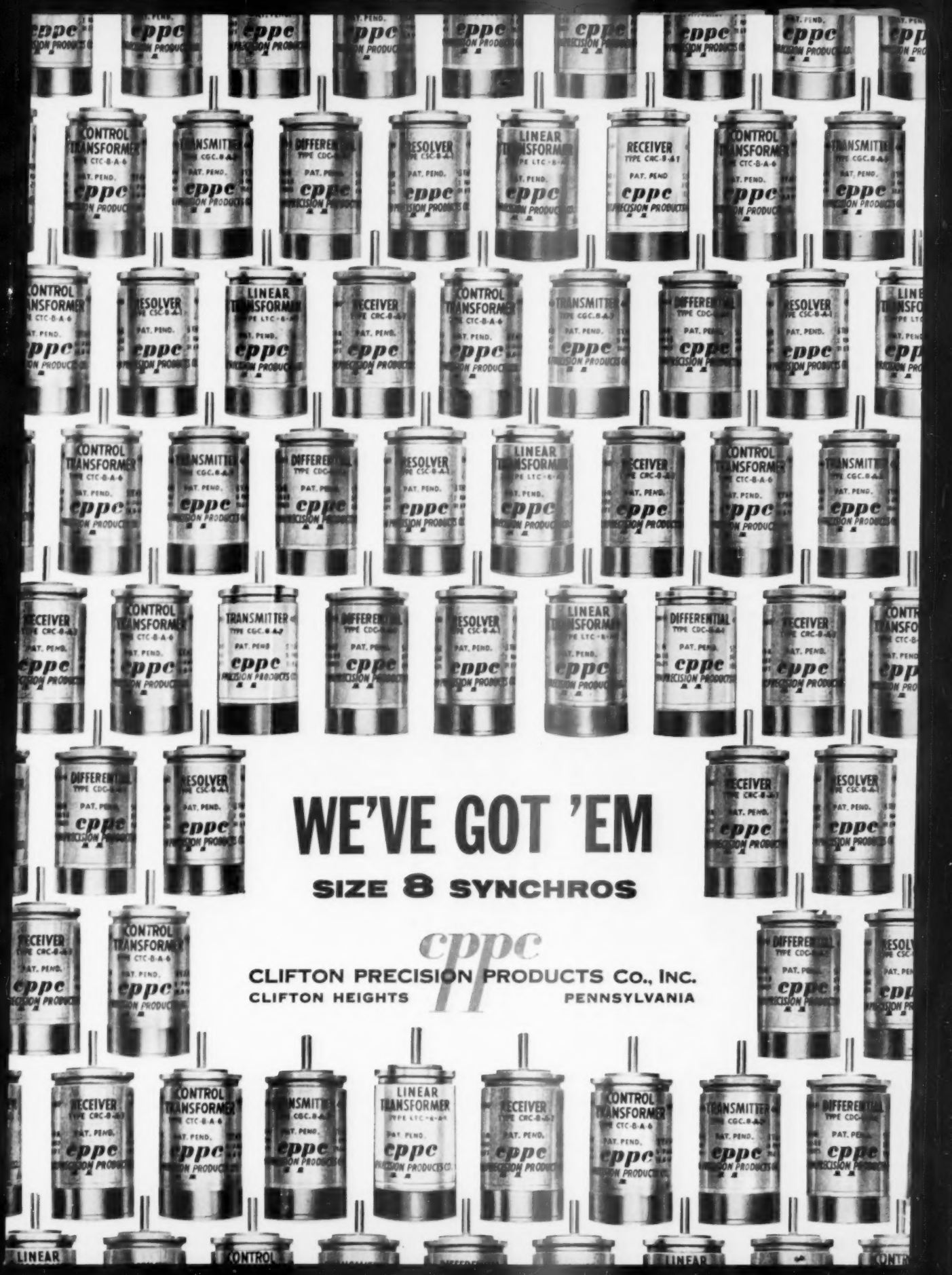
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